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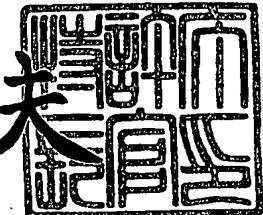
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[Document Name] **SPECIFICATION**
[Title of the Invention] **COMPONENT MOUNTING APPARATUS, PROGRAM
FOR CONTROLLING THE OPERATION AND COMPONENT MOUNTING
SYSTEM**

[Scopes of Patent Claims]

[Claim 1] A component mounting apparatus having two board transfer devices each for transferring boards; component supply devices for supplying plural kinds of components to be mounted on the boards; and a component placing device including a component placing head for picking up components supplied from the component supply devices to mount the picked-up components on the boards and a head moving mechanism for moving the component placing head at least two directions parallel to a surface of the board, the apparatus being characterized in that the component placing device mounts components simultaneously or alternately on two boards which have been transferred by the two board transfer devices to respective component mounting positions.

[Claim 2] The component mounting apparatus of Claim 1, characterized in that the two board transfer devices are conveyors of linear transfer type arranged in parallel relation with each other and that the component supply devices are arranged at outsides of the respective board transfer devices.

[Claim 3] The component mounting apparatus of Claim 1 or 2, characterized in that each of the board transfer devices is adjustable to alter the width thereof in a direction perpendicular to the transfer direction.

[Claim 4] The component mounting apparatus of any one of Claims 1 to 3, characterized in that the component placing head is single.

[Claim 5] The component mounting apparatus of Claim 4, characterized in that the component placing head mounts the components picked up from the component supply devices, on two boards alternately.

[Claim 6] The component mounting apparatus of Claim 4, characterized in

that the component placing head mounts the components picked up from the component supply devices, on two boards alternately at different mounting frequencies.

[Claim 7] The component mounting apparatus of Claim 4, characterized in that the component placing head performs the component mountings intensively onto one of the two boards while the other board is being transferred after the completion of the component mountings thereon, or while the board transfer device for transferring the other board is being adjusted to alter the width thereof.

[Claim 8] The component mounting apparatus of any one of Claims 1 to 3, characterized in that the component placing head comprises two component placing heads, and that the respective component placing heads are movable respectively by different head moving mechanisms.

[Claim 9] The component mounting apparatus of Claim 8, characterized in that one of the component placing heads performs the component mountings mainly on one of the boards, while the other component placing head performs the component mountings mainly on the other board.

[Claim 10] The component mounting apparatus of Claim 9, characterized in that while one of the boards is being transferred after the completion of the component mountings thereon, or while the board transfer device for transferring the one board is being adjusted to alter the width thereof, one of the component placing heads for performing the component mountings mainly on the one board helps the other component placing head in mounting components on the other board and performs the component mountings on the other board.

[Claim 11] The component mounting apparatus of Claim 8, characterized in that the positions to which the two board transfer devices respectively transfer the respective boards for component mountings thereon are different from each

other.

[Claim 12] The component mounting apparatus of Claim 8, characterized in that while one of the component placing heads is performing the component mountings on one of the boards within a predetermined interference risk zone which is around a center portion between the both boards, the other component placing head performs the component mountings on the other board within an interference-free zone which is outside the interference risk zone.

[Claim 13] The component mounting apparatus of Claim 8, characterized in that while one of the boards is being transferred after the completion of the component mountings thereon, or while the board transfer device for transferring the one board is being adjusted to alter the width thereof, the component placing heads perform the component mountings on the other board within a predetermined interference risk zone which is around a center portion between the both boards.

[Claim 14] The component mounting apparatus of any one of Claims 1 to 13, characterized in that means is provided for setting one of the two board transfer devices as exclusive use for regular type products for transferring boards of the regular type products and the other as use for break-in products which are different in board width, for transferring boards of the break-in products.

[Claim 15] The component mounting apparatus of Claim 14, characterized in that for changing the regular type products from the first-type regular products on which component mountings are being performed at the one board transfer device, to second-type regular products, the apparatus further comprises trial production means for effecting component mountings on the boards of the second-type regular products at the other board transfer device on a trial basis prior to such changing; and setting change means for changing the setting means so that at the time of such changing, the other board transfer device is

set as exclusive use for the regular type products for transferring boards of the regular type products only, while the one board transfer device is set as use for the break-in products for transferring boards of the break-in products which are different in board width.

[Claim 16] The component mounting apparatus of any one of Claims 1 to 13, characterized in that for changing the kind of the products on which the component mountings are being performed at the two board transfer devices, from first-type products to second-type products, the apparatus further comprises trial mounting means for performing component mountings on the boards of the second-type products at the other board transfer device on a trial basis when component mountings are being performed on the boards of the first-type products at one of the two board transfer devices, and trial mounting means for performing component mountings on the boards of the second-type products at the one board transfer device after component mountings on a full-scale basis are started on the boards of the second-type products at the other transfer device.

[Claim 17] A component mounting apparatus having two board transfer devices for respectively transferring boards in respective directions parallel to each other, each of the transfer devices being provided with two guide rails for guiding the both sides of each board; two component supply devices provided respectively at the outsides opposite to the center side where the two board transfer devices adjoin to each other; and a component placing device composed of a component placing head for picking up the components supplied from the component supply devices to mount the picked-up components on the boards and a head moving mechanism for moving the component placing head in at least two directions parallel to a surface of the board; characterized in that of respective two guide rails of the respective board transfer devices, respective outside guide rails adjacent to the

component supply devices are fixedly provided, while respective guide rails at the center side are provided adjustably in a direction perpendicular to the direction in which the guide rails extend.

[Claim 18] A component mounting apparatus having two board transfer devices for respectively transferring boards in respective directions parallel to each other, each of the transfer devices being provided with two guide rails for guiding the both sides of each board; two component supply devices provided respectively at the outsides opposite to the center side where the two board transfer devices adjoin to each other; guide rail position adjusting means for adjusting the position of each of the guide rails in a direction perpendicular to the direction in which the guide rails extend; and a component placing device composed of a component placing head for picking up the components supplied from the component supply devices to mount the picked-up components on the boards and a head moving mechanism for moving the component placing head in at least two directions parallel to a surface of the board; characterized in that the guide rail position adjusting means positions respective outside guide rails, adjacent to the component supply devices, of respective two guide rails to the position closest to the component supply devices and also positions respective center side guide rails in dependence on the widths of the boards to be transferred.

[Claim 19] A program for controlling the operation of a component mounting apparatus having two board transfer devices for respectively transferring boards; at least one component supply device for supplying components of plural kinds to be mounted on the boards; and a component placing device composed of at least one component placing head for picking up the components supplied from the component supply device to mount the picked-up components on the boards and a head moving mechanism corresponding in number to the component placing head for moving the component placing head

in at least two directions parallel to a surface of the board; characterized in that the program performs controls in such a way that the component placing device mounts the components simultaneously or alternately on two boards transferred by the two board transfer devices to respective component mounting positions and that while either one board is being transferred after completion of component mountings, or while the board transfer device for transferring the one board is being adjusted to alter the width thereof, the component placing head mounts the components intensively on the other board.

[Claim 20] A program for controlling the operation of a component mounting apparatus having two board transfer devices for respectively transferring boards; at least one component supply device for supplying components of plural kinds to be mounted on the boards; and a component placing device composed of two component placing heads for picking up the components supplied from the component supply device to mount the picked-up components on the boards and two head moving mechanisms for respectively moving the respective component placing heads in at least two directions parallel to a surface of the board; characterized in that the program performs controls in such a way that the component placing device mounts the components simultaneously or alternately on two boards transferred by the two board transfer devices to respective component mounting positions and that while either one component placing head is mounting the components on either one board within a predetermined interference risk zone which is close to the center portion between the both boards, the other component placing head mounts the components on the other board within an interference-free zone excepting the interference risk zone.

[Claim 21] A program for controlling the operation of a component mounting apparatus having two board transfer devices; a component supply device for supplying components of plural kinds to be mounted on boards; a component

placing device composed of a component placing head for picking up the components supplied from the component supply device to mount the picked-up components on the boards and a head moving mechanism for moving the component placing head in at least two directions parallel to a surface of the board; setting means for setting one of the two board transfer devices as exclusive use for regular type products for transferring boards of the regular type products only and the other board transfer device as use for break-in products for transferring boards of the break-in products which are different in width; and rail width adjusting means for adjusting the rail width of each board transfer device; characterized in that the program is designed so that in response to a production command for the break-in products of a certain type other than the regular type products, the board of the regular type products is unloaded from the other board transfer device, a mounting program executed for the other board transfer device is changed to another mounting program corresponding to the break-in products of the certain type, the other board transfer device is adjusted to have a rail width corresponding to the boards of the break-in products of the certain type, and a board of the break-in products of the certain type is loaded to the other board transfer device to have components mounted thereon.

[Claim 22] A program for controlling the operation of a component mounting apparatus having two board transfer devices; a component supply device for supplying components of plural kinds to be mounted on boards; a component placing device composed of a component placing head for picking up the components supplied from the component supply device to mount the picked-up components on the boards and a head moving mechanism for moving the component placing head in at least two directions parallel to a surface of the board; and setting means for setting one of the two board transfer devices as exclusive use for regular type products for transferring boards of the regular

type products only and the other board transfer device as use for break-in products for transferring boards of the break-in products which are different in board width; characterized in that the setting of the setting means is altered so that for changing the regular type products from first regular type products on which component mountings are being performed at one board transfer device, to second regular type products, component mountings on a trial basis are performed on the second regular type products at the other board transfer device prior to such changing, and that at the time of such changing, the other board transfer device is then set as exclusive use for the regular type products for transferring boards of the regular type products only while the one board transfer device is altered as use for the break-in products for transferring boards of the break-in products which are different in board width.

[Claim 23] A program for controlling the operation of a component mounting apparatus having two board transfer devices; a component supply device for supplying components of plural kinds to be mounted on boards; and a component placing device composed of a component placing head for picking up the components supplied from the component supply device to mount the picked-up components on the boards and a head moving mechanism for moving the component placing head in at least two directions parallel to a surface of the board; characterized in that the program performs controls so that when the type of products for which the component mountings are being performed at the two board transfer devices are to be changed from a first type to a second type, component mountings on a trial basis are performed at the other board transfer device for the second type products while component mountings are being performed at the one board transfer device for the first type products and that after component mountings on a full-scale basis are started at the other board transfer device for the second type products, component mountings on the trial basis are performed at the one board transfer

device for the second type products.

[Claim 24] A program for controlling the operation of a component mounting apparatus having two board transfer devices for respectively transferring boards in respective directions parallel to each other, each of the transfer devices being provided with two guide rails for guiding opposite sides of each board; two component supply devices provided respectively at outsides opposite to the side where the two board transfer devices adjoin to each other; guide rail position adjusting means for adjusting the position of each guide rail in a direction perpendicular to the direction in which the guide rail extends; and a component placing device composed of a component placing head for picking up the components supplied from the component supply devices to mount the picked-up components on the boards and a head moving mechanism for moving the component placing head in at least two directions parallel to a surface of the board; characterized in that the program performs controls so that of respective two guide rails, respective outside guide rails adjacent to the component supply devices are positioned to the positions closest to the component supply devices, while respective guide rails on the center side are positioned in dependence on the widths of boards to be transferred.

[Claim 25] A component mounting system using a component mounting apparatus which has two board transfer devices for respectively transferring boards; a component supply device for supplying components of plural kinds to be mounted on the boards; and a component placing device for picking up the components supplied from the component supply device to mount the picked-up components on the boards; characterized in that selection is possible to either one of a first production mode wherein the component placing device mounts components on two boards which have been transferred by the two board transfer devices to respective component mounting positions and a second production mode wherein one board transfer device is used as

mounting conveyor where the component placing device mounts components on the boards, while the other board transfer device is used as bypass conveyor to bypass the boards which are unnecessary to have components mounted thereon by the component placing device.

[Claim 26] A component mounting system using a component mounting apparatus which has two board transfer devices for respectively transferring boards; a component supply device for supplying components of plural kinds to be mounted on the boards; and a component placing device for picking up the components supplied from the component supply device to mount the picked-up components on the boards; characterized in that selection is possible to either one of a first production mode wherein the component placing device mounts components on two boards which have been transferred by the two board transfer devices to respective component mounting positions and a second production mode wherein one board transfer device is used as mounting conveyor where the component placing device mounts components on the boards, while the other board transfer device is used as return conveyor to return the boards which are required again to have components mounted thereon by the component placing device, to a loading side of the component mounting apparatus.

[Claim 27] The component mounting system of Claim 26, characterized in that on the loading side of the component mounting apparatus, a shifting device is provided for transferring the boards returned by the other board transfer device to the loading side, to the one board transfer device, while on an unloading side of the component mounting apparatus, another shifting device with an inspection station is provided for inspecting the boards unloaded from the one board transfer device and for transferring each board which lacks a component but is able to remount the same, to the other board transfer device.

[Detailed Description of the Invention]

[0001]

[Technological Field of the Invention]

The present invention relates to a component mounting apparatus for mounting electronic components on boards, a program for controlling the operation, and a component mounting system.

[0002]

[Prior Art]

Known electronic component mounting apparatus of this kind are of the construction that a single component placing device mounts components supplied from a component supply device, on one board loaded by a single board transfer device, and wherein the component mounting operations are performed on a board-by-board basis. In correspondence to this, a program used in such a component mounting apparatus and a system incorporating such a component mounting apparatus were designed to perform the component mounting operations on a board-by-board basis.

[0003]

[Problem to be solved by the Invention]

As mentioned above, in the known component mounting apparatus, the program and the component mounting system used therefor were designed to perform the component mounting operations on a board-by-board basis, the number of components which could be mounted during unit time period were almost constant. Further, the component mounting operations were discontinued during the transfer operation of the board by the board transfer device. For these reasons, it was difficult to enhance the board productivity.

[0004]

Further, the production line in actual use were of the construction that plural mounting stations each provided with a component mounting apparatus were connected in series. Therefore, a problem arises in that when one

mounting station falls in failure, the production line comes into shutdown as a whole.

[0005]

Moreover, when a board lacking a component but being correctable is detected at a board inspection station arranged in the middle of the production line, the component mountings on the board are continued up to the mounting of the last component for the board, and the lacked component is mounted on the board through a manual reworking or the like. However, this makes the production control complicated.

[0006]

It is an object of the present invention to solve the foregoing various problems by providing a component mounting apparatus with two board transfer devices each capable of performing the loading and unloading of boards and by performing appropriate controls.

[0007]

[Measures for solving the Problems]

In order to solve the foregoing problems, the structural feature of the invention described in Claim 1 resides in a component mounting apparatus having two board transfer devices each for transferring boards; component supply devices for supplying plural kinds of components to be mounted on the boards; and a component placing device including a component placing head for picking up components supplied from the component supply devices to mount the picked-up components on the boards and a head moving mechanism for moving the component placing head at least two directions parallel to a surface of the board, wherein the component placing device mounts components simultaneously or alternately on two boards which have been transferred by the two board transfer devices to respective component mounting positions.

[0008]

The structural feature of the invention according to Claim 2 resides in that in Claim 1, the two board transfer devices are conveyors of linear transfer type arranged in parallel relation with each other and that the component supply devices are arranged at outsides of the respective board transfer devices.

[0009]

The structural feature of the invention according to Claim 3 resides in that in Claim 1 or 2, each of the board transfer devices is adjustable to alter the width thereof in a direction perpendicular to the transfer direction.

[0010]

The structural feature of the invention according to Claim 4 resides in that in any of Claim 1 to 3, the component placing head is single.

[0011]

The structural feature of the invention according to Claim 5 resides in that in Claim 4, the component placing head mounts the components picked up from the component supply devices, on two boards alternately.

[0012]

The structural feature of the invention according to Claim 6 resides in that in Claim 4, the component placing head mounts the components picked up from the component supply devices, on two boards alternately at different mounting frequencies.

[0013]

The structural feature of the invention according to Claim 7 resides in that in Claim 4, the component placing head performs the component mountings intensively onto one of the two boards while the other board is being transferred after the completion of the component mountings thereon, or while the board transfer device for transferring the other board is being adjusted to

alter the width thereof.

[0014]

The structural feature of the invention according to Claim 8 resides in that in any of Claims 1 to 3, the component placing head comprises two component placing heads, and that the respective component placing heads are movable respectively by different head moving mechanisms.

[0015]

The structural feature of the invention according to Claim 9 resides in that in Claim 8, one of the component placing heads performs the component mountings mainly on one of the boards, while the other component placing head performs the component mountings mainly on the other board.

[0016]

The structural feature of the invention according to Claim 10 resides in that in Claim 9, while one of the boards is being transferred after the completion of the component mountings thereon, or while the board transfer device for transferring the one board is being adjusted to alter the width thereof, one of the component placing heads for performing the component mountings mainly on the one board helps the other component placing head in performing the component mountings on the other board and performs the component mountings on the other board.

[0017]

The structural feature of the invention according to Claim 11 resides in that in Claim 8, the positions to which the two board transfer devices respectively transfer the respective boards for component mountings thereon are different from each other.

[0018]

The structural feature of the invention according to Claim 12 resides in that in Claim 8, while one of the component placing heads is performing the

component mountings on one of the boards within a predetermined interference risk zone which is around a center portion between the both boards, the other component placing head performs the component mountings on the other board within an interference-free zone which is outside the interference risk zone.

[0019]

The structural feature of the invention according to Claim 13 resides in that in Claim 8, while one of the boards is being transferred after the completion of the component mountings thereon, or while the board transfer device for transferring the one board is being adjusted to alter the width thereof, the component placing heads perform the component mountings on the other board within a predetermined interference risk zone which is around a center portion between the both boards.

[0020]

The structural feature of the invention according to Claim 14 resides in that in any of Claims 1 to 13, means is provided for setting one of the two board transfer devices as exclusive use for regular type products for transferring boards of the regular type products and the other as use for break-in products which are different in board width, for transferring boards of the break-in products.

[0021]

The structural feature of the invention according to Claim 15 resides in that in Claim 14, for changing the regular type products from the first-type regular products on which component mountings are being performed at the one board transfer device, to second-type regular products, the apparatus further comprises trial production means for effecting component mountings on the boards of the second-type regular products at the other board transfer device on a trial basis prior to such changing; and setting change means for changing the setting means so that at the time of such changing, the other

board transfer device is set as exclusive use for the regular type products for transferring boards of the regular type products only, while the one board transfer device is set as use for the break-in products for transferring boards of the break-in products which are different in board width.

[0022]

The structural feature of the invention according to Claim 16 resides in that in any one of Claims 1 to 13, for changing the kind of the products on which the component mountings are being performed at the two board transfer devices, from first-type products to second-type products, the apparatus further comprises trial mounting means for performing component mountings on the boards of the second-type products at the other board transfer device on a trial basis when component mountings are being performed on the boards of the first-type products at one of the two board transfer devices, and trial mounting means for performing component mountings on the boards of the second-type products at the one board transfer device after component mountings on a full-scale basis are started on the boards of the second-type products at the other transfer device.

[0023]

The structural feature of the invention described in Claim 17 resides in a component mounting apparatus having two board transfer devices for respectively transferring boards in respective directions parallel to each other, each of the transfer devices being provided with two guide rails for guiding the both sides of each board; two component supply devices provided respectively at the outsides opposite to the center side where the two board transfer devices adjoin to each other; and a component placing device composed of a component placing head for picking up the components supplied from the component supply devices to mount the picked-up components on the boards and a head moving mechanism for moving the component placing head in at

least two directions parallel to a surface of the board; wherein of respective two guide rails of the respective board transfer devices, respective outside guide rails adjacent to the component supply devices are fixedly provided, while respective guide rails at the center side are provided adjustably in a direction perpendicular to the direction in which the guide rails extend.

[0024]

The structural feature of the invention described in Claim 18 resides in a component mounting apparatus having two board transfer devices for respectively transferring boards in respective directions parallel to each other, each of the transfer devices being provided with two guide rails for guiding the both sides of each board; two component supply devices provided respectively at the outsides opposite to the center side where the two board transfer devices adjoin to each other; guide rail position adjusting means for adjusting the position of each of the guide rails in a direction perpendicular to the direction in which the guide rails extend; and a component placing device composed of a component placing head for picking up the components supplied from the component supply devices to mount the picked-up components on the boards and a head moving mechanism for moving the component placing head in at least two directions parallel to a surface of the board; wherein the guide rail position adjusting means positions respective outside guide rails, adjacent to the component supply devices, of respective two guide rails to the position closest to the component supply devices and also positions respective center side guide rails in dependence on the widths of the boards to be transferred.

[0025]

The structural feature of the invention described in Claim 19 resides in a program for controlling the operation of a component mounting apparatus having two board transfer devices for respectively transferring boards; at least

one component supply device for supplying components of plural kinds to be mounted on the boards; and a component placing device composed of at least one component placing head for picking up the components supplied from the component supply device to mount the picked-up components on the boards and a head moving mechanism corresponding in number to the component placing head for moving the component placing head in at least two directions parallel to a surface of the board; wherein the program performs controls in such a way that the component placing device mounts the components simultaneously or alternately on two boards transferred by the two board transfer devices to respective component mounting positions and wherein while either one board is being transferred after completion of component mountings, or while the board transfer device for transferring the one board is being adjusted to alter the width thereof, the component placing head mounts the components intensively on the other board.

[0026]

The structural feature of the invention described in Claim 20 resides in a program for controlling the operation of a component mounting apparatus having two board transfer devices for respectively transferring boards; at least one component supply device for supplying components of plural kinds to be mounted on the boards; and a component placing device composed of two component placing heads for picking up the components supplied from the component supply device to mount the picked-up components on the boards and two head moving mechanisms for respectively moving the respective component placing heads in at least two directions parallel to a surface of the board; wherein the program performs controls in such a way that the component placing device mounts the components simultaneously or alternately on two boards transferred by the two board transfer devices to respective component mounting positions and wherein while either one

component placing head is mounting the components on either one board within a predetermined interference risk zone which is close to the center portion between the both boards, the other component placing head mounts the components on the other board within an interference-free zone excepting the interference risk zone.

[0027]

The structural feature of the invention described in Claim 21 resides in a program for controlling the operation of a component mounting apparatus having two board transfer devices; a component supply device for supplying components of plural kinds to be mounted on boards; a component placing device composed of a component placing head for picking up the components supplied from the component supply device to mount the picked-up components on the boards and a head moving mechanism for moving the component placing head in at least two directions parallel to a surface of the board; setting means for setting one of the two board transfer devices as exclusive use for regular type products for transferring boards of the regular type products only and the other board transfer device as use for break-in products for transferring boards of the break-in products which are different in width; and rail width adjusting means for adjusting the rail width of each board transfer device; characterized in that the program is designed so that in response to a production command for the break-in products of a certain type other than the regular type products, the board of the regular type products is unloaded from the other board transfer device, a mounting program executed for the other board transfer device is changed to another mounting program corresponding to the break-in products of the certain type, the other board transfer device is adjusted to have a rail width corresponding to the break-in products of the certain type, and a board of the break-in products of the certain type is loaded to the other board transfer device to have components mounted

thereon.

[0028]

The structural feature of the invention described in Claim 22 resides in a program for controlling the operation of a component mounting apparatus having two board transfer devices; a component supply device for supplying components of plural kinds to be mounted on boards; a component placing device composed of a component placing head for picking up the components supplied from the component supply device to mount the picked-up components on the boards and a head moving mechanism for moving the component placing head in at least two directions parallel to a surface of the board; and setting means for setting one of the two board transfer devices as exclusive use for regular type products for transferring boards of the regular type products only and the other board transfer device as use for break-in products for transferring boards of the break-in products which are different in board width; characterized in that the setting of the setting means is altered so that for changing the regular type products from first regular type products on which component mountings are being performed at one board transfer device, to second regular type products, component mountings on a trial basis are performed on the second regular type products at the other board transfer device prior to such changing, and that at the time of such changing, the other board transfer device is then set as exclusive use for the regular type products for transferring boards of the regular type products only while the one board transfer device is altered as use for the break-in products for transferring boards of the break-in products which are different in board width.

[0029]

The structural feature of the invention described in Claim 23 resides in a program for controlling the operation of a component mounting apparatus having two board transfer devices; a component supply device for supplying

components of plural kinds to be mounted on boards; and a component placing device composed of a component placing head for picking up the components supplied from the component supply device to mount the picked-up components on the boards and a head moving mechanism for moving the component placing head in at least two directions parallel to a surface of the board; wherein the program performs controls so that when the type of products for which the component mountings are being performed at the two board transfer devices are to be changed from a first type to a second type, component mountings on a trial basis are performed at the other board transfer device for the second type products while component mountings are being performed at the one board transfer device for the first type products and that after component mountings on a full-scale basis are started at the other board transfer device for the second type products, component mountings on the trial basis are performed at the one board transfer device for the second type products.

[0030]

The structural feature of the invention described in Claim 24 resides in a program for controlling the operation of a component mounting apparatus having two board transfer devices for respectively transferring boards in respective directions parallel to each other, each of the transfer devices being provided with two guide rails for guiding both sides of each board; two component supply devices provided respectively at outsides opposite to the side where the two board transfer devices adjoin to each other; guide rail position adjusting means for adjusting the position of each guide rail in a direction perpendicular to the direction in which the guide rail extends; and a component placing device composed of a component placing head for picking up the components supplied from the component supply devices to mount the picked-up components on the boards and a head moving mechanism for

moving the component placing head in at least two directions parallel to a surface of the board; wherein the program performs controls so that of respective two guide rails, respective outside guide rails adjacent to the component supply devices are positioned to the positions closest to the component supply devices, while respective guide rails on the center side are positioned in dependence on the widths of boards to be transferred.

[0031]

The structural feature of the invention described in Claim 25 resides in a component mounting system using a component mounting apparatus which has two board transfer devices for respectively transferring boards; a component supply device for supplying components of plural kinds to be mounted on the boards; and a component placing device for picking up the components supplied from the component supply device to mount the picked-up components on the boards; wherein selection is possible to either one of a first production mode wherein the component placing device mounts components on two boards which have been transferred by the two board transfer devices to respective component mounting positions and a second production mode wherein one board transfer device is used as mounting conveyor where the component placing device mounts components on the boards, while the other board transfer device is used as bypass conveyor to bypass the boards which are unnecessary to have components mounted thereon by the component placing device.

[0032]

The structural feature of the invention described in Claim 26 resides in a component mounting system using a component mounting apparatus which has two board transfer devices for respectively transferring boards; a component supply device for supplying components of plural kinds to be mounted on the boards; and a component placing device for picking up the components

supplied from the component supply device to mount the picked-up components on the boards; wherein selection is possible to either one of a first production mode wherein the component placing device mounts components on two boards which have been transferred by the two board transfer devices to respective component mounting positions and a second production mode wherein one board transfer device is used as mounting conveyor where the component placing device mounts components on the boards, while the other board transfer device is used as return conveyor to return the boards which are required again to have components mounted thereon by the component placing device, to a loading side of the component mounting apparatus.

[0033]

The structural feature of the invention described in Claim 27 resides in that in the component mounting system of Claim 26, on the loading side of the component mounting apparatus, a shifting device is provided for transferring the boards returned by the other board transfer device to the loading side, to the one board transfer device, while on an unloading side of the component mounting apparatus, another shifting device with an inspection station is provided for inspecting the boards unloaded from the one board transfer device and for transferring each board which lacks a component but is able to remount the same, to the other board transfer device.

[0034]

[Operation of the Invention and Effect thereof]

In the invention of Claim 1 as constructed above, components are mounted by the component placing device simultaneously or alternately on two boards transferred by the two board transfer devices, so that the component mountings on each board can be done efficiently. Further, where the timings when the two board transfer devices respectively transfer the boards are shifted from each other, it can be realized to perform the component mountings

on either one board during the transferring of the other board. This prevents the board transfer operation from causing the component mounting operations to be discontinued, so that the productivity of the boards can be enhanced even though the number of components which can be mounted during unit time remains unchanged.

[0035]

In the invention of Claim 2 as constructed above, according to the component mounting apparatus wherein the two board transfer devices are made as being of the linear transfer type and arranged in parallel relation with each other and wherein the component supply devices are arranged at the outsides of the respective board transfer devices, the distances between the respective boards loaded by the two board transfer devices and the respective component supply devices are reduced in average, and therefore, the time taken for the component placing device to mount components from the component supply device onto each board can be shortened, so that the productivity of the boards can be further enhanced.

[0036]

In the invention of Claim 3 as constructed above, since the component mounting apparatus is adjustable to alter the width of each board transfer devices in a direction perpendicular to the transfer direction, the single component mounting apparatus has a capability of performing the component mountings on the boards of various kinds which are different in width.

[0037]

In the invention of Claim 4 as constructed above, because of the single component placing head, the component mounting apparatus can be simplified in construction and can be made to be suitable for the production of boards which are small in the number of components mounted thereon.

[0038]

In the invention of Claim 5 or 6 as constructed above, the single component placing head is used in mounting components alternately on two boards S or in mounting components alternately on two boards S at different mounting frequencies. Thus, the efficiency in mounting components on each board can be enhanced.

[0039]

In the invention of Claim 7 as constructed above, while either one board is being transferred after completion of component mountings or while the board transfer device for transferring the one board is adjusting the width thereof, the component placing head performs the component mountings intensively on the other board, so that the efficiency in mounting components on the other board at that time can be enhanced.

[0040]

In the invention of Claim 8 as constructed above, two placing heads are provided, wherein they can be moved by the respective head moving mechanisms independently of each other. Thus, with the increase in number of the placing heads, the number of components which can be mounted during unit time period increases, so the productivity of the boards can be further enhanced.

[0041]

In the invention of Claim 9 as constructed above, either one component placing head performs the component mountings mainly on either one board, while the other component placing head performs the component mountings mainly on the other board. Thus, the program for controlling the operation of the component mounting apparatus can be simplified.

[0042]

In the invention of Claim 10 as constructed above, while either one board is being transferred after completion of component mountings or while

the board transfer device for transferring the one board is being adjusted to alter the width thereof, one component placing head for performing the component mountings mainly on the one board helps the other component placing head in performing the component mountings on the other board and performs component mountings on the other board, so that the efficiency in mounting the components on the other board at that time can be enhanced.

[0043]

In the invention of Claim 11 as constructed above, according to the component mounting apparatus wherein the component mounting positions to which the respective boards are transferred by the two board transfer devices are made to be different from each other, the chance for the two component placing heads to interfere with each other in mounting components on the respective boards can be obviated, so that the efficiency of the component mountings on the both boards can be enhanced, and at the same time, the program for controlling the operation of the board mounting apparatus can be simplified.

[0044]

In the invention of Claim 12 as constructed above, while either one component placing head is mounting components on either one board within the predetermined interference risk zone which is around the center portion between the both boards, the other component placing head mounts components on the other board within an interference-free zone excepting the interference risk zone. This obviates the chance for the two component placing heads to interfere with each other in mounting components on the respective boards, so that the efficiency in mounting components on the both boards can be enhanced.

[0045]

In the invention of Claim 13 as constructed above, while either one

board is being transferred after completion of component mountings or while the board transfer device for transferring the one board is being adjusted to alter the width thereof, the component placing head mounts the components on the other board at the interference risk zone which is adjacent to the center portion between the both boards. Thus, in simultaneously mounting components on the both boards, the component mountings within the interference risk zone can be performed without any chance for the two component placing heads to interfere with each other. Thus, the efficiency in mounting components on the respective boards can be enhanced.

[0046]

In the invention of Claim 14 as constructed above, of the two board transfer devices, one is set as exclusive use for the regular type products for transferring the boards of the regular type products, while the other is set as use for break-in products for transferring the boards of break-in products which are different in board width. Thus, when a production command for the break-in products is given during the production of the regular type products, it becomes possible to rearrange in the absence of disorder the board transfer device only which has been set as use for the break-in products, for the break-in products without making rearrangements of the two board transfer devices, so that such rearrangement can be done in a short time period at a low cost.

[0047]

In the invention of Claim 15 as constructed above, where the regular type products are to be changed from the first regular type products to the second type products, a trial basis production of the second type products is performed at the other transfer device which has been set for the break-in products, while the component mountings are being continued for the first type products at one board transfer device. And, if the trial basis production does not give rise to any problem, the other board transfer device is set as exclusive

use for the regular type products to perform the component mountings for the second type products on a full-scale basis, and the one board transfer device is set as use for the break-in products. Therefore, in addition to the advantages described in connection with Claim 14, any problem accompanied by the production of the second type products can be extracted prior to the full-scale basis production thereof and without discontinuing the production operation. Therefore, the occurrence of poor quality after the starting of the full-scale basis production can be obviated, so that the change in product type can be made smoothly.

[0048]

In the invention of Claim 16 as constructed above, where the products on which the component mountings are being performed at the two board transfer devices are to be changed from the first type products to the second type products, a trial basis production of the second type products are performed at the other board transfer device while the component mountings on the first type products are being performed at one transfer device. And, if the trial basis production does not give rise to any problem, the component mountings on the boards for the second type product are then performed on a full-scale basis. Thereafter, if any problem does not result from the trial basis component mounting operations for the second type products at the one board transfer device, the component mountings on a full-scale basis for the second type products are initiated at the one board transfer device. Therefore, any problem accompanied can be extracted prior to the full-scale basis production of the second type products without discontinuing the production. Consequently, the occurrence of poor quality after the starting of the full-scale basis production can be obviated, so that the change in product type can be made smoothly.

[0049]

In the invention of Claim 17 as constructed above, of the two guide rails which are provided on each of the two board transfer devices for guiding the both sides of the board, each outside guide rail adjacent to the component supply device is fixed, while each center side guide rail is adjustably positioned in a direction perpendicular to the lengthwise direction of the guide rails. Thus, when the space between each two guide rails is set to be narrow, an extra space is formed between the movable rails at the center side of each board transfer device, and the two boards are separated with the extra space, so that the chance for the component placing heads to interfere can be minimized.

[0050]

In the invention of Claim 18 as constructed above, the two board transfer devices for transferring the boards in respective directions parallel to each other guide the both sides of each board with two guide rails thereof. The position of each guide rail is adjustable by the guide rail position adjusting means in dependence on the width of a board in a direction perpendicular to the lengthwise direction thereof. The guide rail position adjusting means positions the outside guide rails on the side of the component supply devices, to the positions closest to the component supply devices and also positions the center side guide rails in dependence upon the widths of the boards. Thus, when each two guide rails are narrowed in width, an extra space is formed between the center side guide rails. This extra space further separates the two boards transferred by the respective board transfer devices, so that the chance for the component placing heads to interfere can be minimized.

[0051]

In the invention of Claim 19 as constructed above, the component mounting apparatus comprises two board transfer devices for respectively transferring boards; at least one component supply device for supplying components of plural kinds to be mounted on the boards; and a component

placing device composed of at least one component placing head for picking up the components supplied from the component supply device to mount the picked-up components on the boards and a head moving mechanism corresponding in number to the component placing head for moving the component placing head in at least two directions parallel to a surface of the board. The program for controlling the operation of the component mounting apparatus performs controls in such a way that the component placing device mounts the components simultaneously or alternately on two boards transferred by the two board transfer devices to respective component mounting positions and that while either one board is being transferred after completion of component mountings or while the board transfer device for transferring the one board is being adjusted to alter the width thereof, the component placing head mounts the components intensively on the other board. Accordingly, the efficiency in mounting the components on the other board at that time can be enhanced.

[0052]

In the invention of Claim 20 as constructed above, the component mounting apparatus comprises two board transfer devices for respectively transferring boards; at least one component supply device for supplying components of plural kinds to be mounted on the boards; and a component placing device composed of two component placing heads for picking up the components supplied from the component supply device to mount the picked-up components on the boards and two head moving mechanisms for respectively moving the respective component placing heads in at least two directions parallel to a surface of the board. The program for controlling the operation of the component mounting apparatus performs controls in such a way that the component placing device mounts the components simultaneously or alternately on two boards transferred by the two board transfer devices to

respective component mounting positions and that while either one component placing head is mounting the components on either one board within the predetermined interference risk zone which is close to the center portion between the both boards, the other component placing head mounts the components on the other board at the interference-free zone excepting the interference risk zone. Therefore, the chance for the two component placing heads to interfere with each other in mounting components on the respective boards can be obviated, so that the efficiency in mounting the components on the both boards can be enhanced.

[0053]

In the invention of Claim 21 as constructed above, of the two board transfer devices in the component mounting apparatus, one is set as exclusive use for regular type products for transferring boards of the regular type products only, while the other is set as use for break-in products for transferring boards of the break-in products which are different in width. In response to a production command for the break-in products of a certain type other than the regular type products, the program for controlling the operation of the component mounting apparatus stops loading the boards of the regular type products onto the other board transfer device and unloads all therefrom, changes a mounting program executed for the other board transfer device to another mounting program corresponding to the break-in products of the certain type, adjusts the other board transfer device to have a rail width corresponding to the break-in products of the certain type, and loads a board of the break-in products of the certain type to the other board transfer device to have components mounted thereon. Thus, when the command for the production of the break-in products is given during the production of the regular type products, the two board transfer devices are not required to be rearranged, and instead, only the board transfer device set for the break-in products can be

rearranged for the break-in products without falling into the state of disorder. This makes it possible to perform the rearrangement within a short time period and at low cost.

[0054]

In the invention of Claim 22 as constructed above, the program for controlling the operation of the component mounting apparatus is designed so that where the regular type products are to be changed from the first regular type products to the second type products, a trial basis production of the second type products is performed at the other transfer device which has been set for the break-in products while the component mountings are being continued at one board transfer device. And, if the trial basis production does not give rise to any problem, settings are changed to set the other board transfer device as exclusive use for the regular type products and to set the one board transfer device as use for the break-in products. Thus, when the command for change to the second regular type products is given during the production of the first regular type products, the two board transfer devices are not required to be rearranged, and instead, only the board transfer device set as use for the break-in products can be rearranged for the second regular type products without falling into the state of disorder. In this way, without discontinuing the production, any problem can be extracted by performing the trial basis component mountings on the second regular type products at the other board transfer device. The occurrence of poor quality after the starting of the full-scale basis production can be obviated, so that the change in the product type can be made smoothly.

[0055]

In the invention of Claim 23 as constructed above, the program for controlling the operation of the component mounting apparatus performs controls so that where the products on which the component mountings are

being performed at the two board transfer devices are to be changed from the first type products to the second type products, the trial basis production of the second type products is performed at the other transfer device while the component mountings on the first type products are being performed at one board transfer device and that if any problem does not occur, the trial component mountings on the second type products are performed at the one board transfer device after the full-scale component mountings on the second type products are started at the other board transfer device, and if any problem does not occur, the full-scale component mountings are performed. Therefore, any problem can be extracted through the trial component mountings on the second type products without discontinuing the production, and the occurrence of poor quality after the starting of the full-scale basis production can be obviated, so that the change in the product type can be made smoothly.

[0056]

In the invention of Claim 24 as constructed above, the program for controlling the operation of the component mounting apparatus, wherein the two board transfer devices for transferring the boards in respective directions parallel to each other guide the both sides of each board with two guide rails thereof and wherein each guide rail is adjustable in a direction perpendicular to the lengthwise direction thereof, positions the outside guide rails on the sides of the component supply devices of the respective two guide rails to the positions closest to the component supply devices and also positions the center side guide rails in dependence upon the boards to be loaded. Thus, when each two guide rails are narrowed in width, an extra space is formed between the center side guide rails, and the two boards transferred by the respective board transfer devices are separated further, so that the chance for the two component placing heads to interfere can be minimized.

[0057]

In the invention of Claim 25 as constructed above, the component mounting system employs a component mounting apparatus which comprises two board transfer devices for respectively transferring boards, a component supply device for supplying components of plural kinds to be mounted on the boards and a component placing device for picking up the components supplied from the component supply device to mount the picked-up components on the boards, and in the system, either one of the first and second production modes is selectable. In the first production mode, the component placing device mounts components on two boards which have been transferred by the two board transfer devices to respective component mounting positions. In the second production mode, one board transfer device is used as mounting conveyor which transfers a loaded board to a mounting position where the component placing device performs the component mountings, while the other board transfer device is used as bypass conveyor which bypasses a board on which the component placing device does not perform component mountings.

[0058]

Thus, when a certain component mounting apparatus falls in difficulties in a production line with plural component mounting apparatus connected in series, it becomes possible to make the other board transfer device bypass the board and to make a component mounting apparatus on the downstream side perform component mountings, so that it dose not occur that the production line falls in shutdown as a whole. Further, the boards which are small in the number of the components to be mounted thereon can be made to bypass any component mounting apparatus which does not perform the component mounting operations on the boards, so that it can also becomes possible to enhance the productivity of the boards.

[0059]

In the invention of Claim 26 as constructed above, the component

mounting system employs a component mounting apparatus which comprises two board transfer devices for respectively transferring boards, a component supply device for supplying components of plural kinds to be mounted on the boards and a component placing device for picking up the components supplied from the component supply device to mount the picked-up components on the boards, and in the system, either one of the first and second production modes is selectable. In the first production mode, the component placing device mounts components on two boards which have been transferred by the two board transfer devices to respective component mounting positions. In the second production mode, one board transfer device is used as mounting conveyor which transfers a loaded board to a mounting position where the component placing device performs the component mountings, while the other board transfer device is used as return conveyor which returns a board which is required to have a component again mounted thereon, to the loading side of the component mounting apparatus. Thus, where the board which has been unloaded from the one board transfer device lacks a component which can be given a minor correction, the lacked component can be remounted by detecting the lack of the component from the unloaded board and by returning the unloaded board to the loading side of the component mounting apparatus by the other board transfer device. Accordingly, because it becomes unnecessary to remount the lacked components after the mountings of the boards are completed in the production line, the production control coping with the lacks of components can be simplified.

[0060]

In the invention of Claim 27 as constructed above, the board which has been unloaded by one board transfer device from the component mounting apparatus is inspected by the shifting device with the inspection station. If the board lacks a component, but is possible to have the same remounted, it is

shifted onto the other board transfer device to be returned to the loading side. Then, the board is shifted by the shifting device onto the one board transfer device, so that it becomes possible to perform the remounting of the lacked component automatically.

[0061]

[Embodiments of the Invention]

A component mounting apparatus, a program for controlling the operation thereof and a component mounting system according to the present invention will be described hereinafter by reference to the embodiments shown in the accompanying drawings. First of all, the component mounting apparatus according to the present invention will be described with reference to Figures 1 to 3. This component mounting apparatus is composed of first and second board transfer devices 10a, 10b, conveyor width adjusting devices 30 respectively associated with the board transfer devices 10a, 10b, a component placing device 40 and first and second component supply devices 45a, 45b.

[0062]

The first and second board transfer devices 10a, 10b take substantially the same construction, and therefore, the first board transfer devices 10a will be mainly described. As shown in Figures 2 and 3, a pair of outside support pedestals 12 are upright fixed on a base 11, and a pair of inside support pedestals 12a which face the outside support pedestals 12 are upright fixed respectively on sliders 15a which are slidably carried on the base 11 along guide rails 15 perpendicular to the outside support pedestals 12, so that the distance between the outside support pedestals 12 and the inside support pedestals 12a are made to be variable. Opposite end portions of support plates 13 are secure respectively to upper portions of the support pedestals 12, 12a, and side rails 14 are fixed on the top ends of the support plates 13 protruding upward from the respective support pedestals 12, 12a. Upper edges of the

respective side rails 14 are formed respectively with flange portions 14a which protrude inwardly beyond the support rails 20. The second board transfer device 10b is provided on the base 11 in parallel relation and symmetrically with the first board transfer device 10a, with the inside support pedestals 12a adjoining to each other. Further, on the base 11, a support plate 39 is upright fixed at the outside of the outside support pedestal 12 of the second board transfer device 10b.

[0063]

The opposite end portions of a transfer rotary shaft 16 which is arranged to extend perpendicularly of the support plates 13 are rotatably carried respectively in the outside support pedestals 12 of the respective board transfer devices 10a, 10b. A spline shaft portion 16a which occupies almost all of the middle portion passes through the inside support pedestals 12a rotatably and axially movably. Outside drive pulleys 17 are secured respectively onto the opposite end portions adjoining to the outside support pedestals 12, of the transfer rotary shaft 16. The inside support pedestals 12a are formed with boss portions through which the spline shaft portion 16a passes, and inside drive pulleys 17a are carried respectively on the boss portions to be rotatable and not to be axially movable. The respective inside drive pulleys 17a are spline-engaged with the spline shaft portion 16a to be slidable thereon, so the rotation of the transfer rotary shaft 16 can be transmitted to the inside drive pulleys 17a.

[0064]

As shown mainly in Figure 3, the support plate 13 secured to the inside support pedestal 12a rotatably carry pairs of pulleys 18, 19 at opposite ends slightly below the side rails 14 and at lower inside portions, and pulleys 19a, 19b are rotatably supported under between the pulleys 18 and 19. A conveyor belt 21 with a T-shape cross-section is wound between the inside drive pulley 17a and these pulleys 18, 19, 19a, 19b. Each of the pulleys 17a, 18 and 19a is

formed with a circumferential groove which is engageable complementally with the T-shape cross-section of the conveyor belt 21 so as to prevent the same from being dislocated therefrom. A part of each conveyor belt 21 expanded between the pair of pulleys 18 resides maintaining a constant distance from the flange portion 14a of the corresponding side rail 14. The support rail 20 is secured to the support plate 13 between the pulleys 18, 18 and has formed thereon a longitudinal groove whose cross-section is complementarily fitted with the T-shape cross-section of the conveyor belt 21, for supporting that part of the conveyor belt 21. Likewise, the support plate 13 secured to the outside support pedestal 12 is provided with pulleys 18, 19, 19a, 19b. A conveyor belt 21 is wound between the outside drive pulley 17 and these pulleys 18, 19, 19a, 19b, and a support rail 20 is provided for supporting the conveyor belt 21.

[0065]

One end of the transfer rotary shaft 16 protrudes from the support plate 39 through the outside support pedestal 12 of the second board transfer device 10b and has a pulley 16b secured to an end portion thereof. A conveyor drive motor 22 is supported on the base 11 (the supporting structure not shown), and a drive belt 23 is provided between a pulley 22a secured to an output shaft of the conveyor drive motor 22 and the pulley 16b. The conveyor belts 21 are moved by driving the respective drive pulleys 17, 17a through the transfer rotary shaft 16. The aforementioned board transfer devices 10a, 10b form two conveyors of a linear transfer type for loading two boards Sa, Sb onto the component mounting apparatus and for unloading the same therefrom.

[0066]

Between the inside and outside support rails 20 at the upper part of each board transfer device 10a, 10b, there is provided a backup device 24 which comprises a backup plate 24a movable up and down by an elevation device (not shown) and a plurality of backup pins 24b upright fixed on the top

of the backup plate 24a. The illustrated backup device 24 is not variable with respect to the width in a direction perpendicular to the transfer direction. Therefore, the backup plate is to be replaced each time the width of the board transfer device 10a, 10b in the direction perpendicular to the transfer direction is changed by the conveyor width adjusting device 30 referred to later. However, the backup device 24 is not limited to this and may be one the width of which is automatically changeable in synchronized relation with the operation of the conveyor width adjusting device 30, in which case it can be unnecessary to replace the backup device 24 each time the width of the board transfer device 10a, 10b is changed. Although in Figure 2, the backup device 24 only for the second board transfer device 10b is shown for brevity in illustration, the backup plate 24 is also provided for the first board transfer device 10a.

[0067]

The boards Sa, Sb are loaded into and unloaded from the component mounting apparatus with both side edges thereof being supported by the respective conveyor belts 21 of the first and second board transfer devices 10a, 10b. After being transferred to predetermined positions, the boards Sa, Sb are lifted up with the elevation of the backup devices 24 and are positioned to respective component mounting positions as a result of being brought into abutting engagement with the flange portion 14a of each side rail 14.

[0068]

In this particular embodiment, the transfer rotary shaft 16 is used in common to both of the first and second board transfer devices 10a, 10b and is rotated to drive the conveyor belts 21 of the both board transfer devices 10a, 10b. However, the drive device for the conveyor belts 21 is not constrained to this type. Respective transfer rotary shafts 16 may be provided for the first and second board transfer devices 10a, 10b and may be rotated by individual conveyor drive motors 22. In the case of being so modified, it becomes realized

to drive the conveyor belts 21 of the transfer devices 10a, 10b independently of each other. In this case, the respective transfer rotary shafts 16 can be provided being carried respectively on the respective support pedestals 12, 12a which are on the mutually opposite sides as viewed in Figure 3.

[0069]

Next, the conveyor width adjusting devices 30 will be described with reference to Figures 2 and 3. A pair of first screw shafts 31 arranged in parallel to the transfer rotary shaft 16 are for altering the distance between the both of the support pedestals 12, 12a of the first board transfer device 10a and hence, the distance between the support plates 13 secured to the support pedestals 12, 12a. Each of the first screw shafts 31 is rotatably carried at its opposite ends in the both outside support pedestals 12 of the first and second transfer devices 10a, 10b and rotatably and axially movably passes at its middle portion through the inside support pedestal 12a of the second board transfer device 10b. A threaded portion of each screw shafts 31 which is formed mainly on the side of the first board transfer device 10a is thread-engaged with the boss portion which is formed on the inside support pedestal 12a of the first board transfer device 10a. Passing through the outside support pedestal 12 of the second board transfer device 10b, one end of each first screw shaft 31 is protruded from the support plate 39 and has a pulley 31a secured thereto. The both pulleys 31a are in driving connection with each other with a connection belt 32 being wound between the half portions on one side. A first drive motor 33 is supported (the supporting structure not shown) on the base 11, and a drive belt 34 is wound between a pulley 33a secured to an output shaft of the first drive motor 33 and the remaining half portion of one of the pulleys 31a. Thus, the both first screw shafts 31 are synchronously rotated by the first drive motor 33 thereby to alter the width of the first board transfer device 10a in the direction perpendicular to the transfer direction (i.e., the distance between the both

support plates 13 secured to the both support pedestals 12, 12a and hence, the distance between the side rails 14).

[0070]

Another pair of second screw shafts 35 arranged in parallel to the transfer rotary shaft 16 are for altering the distance between the both support pedestals 12, 12a of the second board transfer device 10b and hence, the distance between the support plates 13 supported by the support pedestals 12, 12a. Each of the second screw shafts 35 is rotatably carried at its opposite ends in the outside support pedestals 12 of the both board transfer devices 10a, 10b and rotatably and axially movably passes at its middle portion through the inside support pedestals 12a of the first board transfer device 10a. A threaded portion which is formed mainly on the side of the second board transfer device 10b is thread-engaged with the boss portion which is formed on the inside support pedestal 12a of the second board transfer device 10b. Other parts concerned are substantially the same in construction as those parts of the first screw shafts 31. Thus, the other parts are omitted from being described in detail wherein however, the corresponding members are denoted using reference numerals which are respectively larger by "4" than those used for the first screw shafts 31 section. With rotation of the second drive motor 37, the both second screw shafts 35 are rotated synchronously with each other, whereby the width of the second board transfer device 10b in a direction perpendicular to the transfer direction can be altered independently of that of the first board transfer device 10a.

[0071]

In this particular embodiment, the respective inside support pedestals 12a of the respective board transfer devices 10a, 10b are movable independently of each other with the respective outside support pedestals 12 being fixed on the base 11, so that the widths of the respective board transfer

devices 10a, 10b can be altered independently. However, the structure is not restricted to this type, and the respective inside support pedestals may be fixed on the base 11, and the respective outside support pedestals 12 may be movable with the two screw shafts independently. Or, the outside support pedestal 12 of one of the board transfer devices 10a, 10b and the inside support pedestal 12a of the other board transfer device may be fixed on the base 11, and the remaining inside support pedestal and the remaining outside support pedestal may be independently movable with the two screw shafts. Further instead, only the outside support pedestal 12 of one of the board transfer devices 10a, 10b may be fixed on the base 11, the two inside support pedestals may be bodily movable with a screw shaft, and the other outside support pedestal 12 may be movable with another screw shaft independently of the two inside support pedestals.

[0072]

As shown in Figure 1, the component placing device 40 is composed of a pair of fixed rails 41 which are supported on the base 11, being arranged over the opposite ends of the both board transfer devices 10a, 10b in parallel relation with each other, two head guide rails 42a, 42b which are arranged perpendicularly to the fixed rails 41 with both ends thereof being supported movably along the fixed rails 41 and two component placing heads 43a, 43b supported movably respectively along the head guide rails 42a, 42b. The fixed rails 41 and the head guide rails 42a, 42b constitute head moving mechanisms for feeding the component placing heads 43a, 43b in at least two directions parallel to a surface of each board Sa, Sb. Each of the component placing heads 43a, 43b is provided with a vertically movable suction nozzle (not shown) for attracting a component thereto. The head guide rails 42a, 42b, the component placing heads 43a, 43b and the suction nozzles are controlled respectively by servomotors (not shown), so that the suction nozzles

successively attract and hold plural components supplied from component supply devices 45a, 45b referred to next and successively mounts the components on the boards Sa, Sb held at the component mounting positions on the board transfer devices 10a, 10b, as described earlier.

[0073]

As shown in Figure 1, each of the component supply devices 45a, 45b comprises a plurality of feeders juxtaposed on a feeder table. Each feeder is of a tape-feed type, for example. This tape-feed type feeder contains a slender tape, which has enclosed components at a regular pitch, in such a way that the tape is wound about a supply reel and is able to feed the components, which can be attracted (taken) by the suction nozzle of the component placing head, one by one to its extreme end close to the board transfer device 10a, 10b. The tape comprises a base tape retaining the components thereon and a cover tape covering the same. At the extreme end of each feeder, the cover tape is peeled off from the base tape thereby to enable each component to be attracted, and the base tape from which components have been taken out is turned down to be wound. Although in this particular embodiment, the component supply devices 45a, 45b are provided respectively at both outsides of the first and second board transfer devices 10a, 10b, namely one at each outside thereof, only one component supply device may be provided outside one of the both board transfer devices 10a, 10b.

[0074]

The operation of the component mounting apparatus is controlled by a controller 60 shown in Figure 4. The controller 60 is further connected to a communication unit 61, an input unit 64, a display monitor 65, a memory unit 63 and a mounting schedule preparation unit 62. The communication unit 61 is operable to communicate with a host computer which supervises a production line including the component mounting apparatus. Via the communication unit

61, mounting data for each kind of products (the kinds of components to be mounted and mounting coordinates data therefor) and production schedule data (data indicative of the production sequence and the number of production on a board type basis) are transmitted to the component mounting apparatus from the host computer.

[0075]

The mounting schedule preparation unit 62 prepares a mounting program which is actually executed by the component mounting apparatus, based on the mounting data for respective kinds of the products and the production schedule data which have been transmitted from the host computer. More specifically, the preparation unit 62 determines a mounting sequence taking into account the most suitable arrangement of the feeders within the component supply devices 45a, 45b which depends on the respective numbers on a kind-by-kind basis of the boards scheduled to be produced, and the respective mounting speed rates in the case that boards of two kinds are produced simultaneously, and prepares a mounting program capable of obviating such a situation that the productivity is lowered due to the two board transfer devices 10a, 10b both transferring the boards Sa, Sb at the same time. The mounting program preparation processing performed by the mounting schedule preparation unit 62 may be executed by the host computer, and the prepared mounting program may be transmitted to the component mounting apparatus.

[0076]

The memory unit 63 stores various programs, data, log and the like which relates to the component mounting apparatus. In this particular embodiment, the memory unit 63 stores therein the mounting data and production schedule data which are transmitted from the host computer on a kind-by-kind basis and mounting programs which are prepared by the mounting

schedule preparation unit 62 based on such data and information. The input unit 64 includes a keyboard and push buttons for inputting necessary data and commands. The display monitor 65 comprises a display device such as LCD or CRT for displaying necessary information.

[0077]

The operation of the component mounting apparatus as constructed above will be described hereafter.

(First Embodiment)

First of all, the operation of the first embodiment provided with the two board transfer devices 10a, 10b, the two component supply devices 45a, 45b and the component placing device 40 having a single component placing head 43 will be described with reference to Figures 5 to 7. As mentioned earlier, the component mounting apparatus in the first embodiment is operated in accordance with a mounting program which is designed to obviate the situation that the two board transfer devices 10a, 10b are both in operation to transfer the boards Sa, Sb.

[0078]

The operation of the first embodiment will be described with reference to a flow chart shown in Figure 24. When neither of the both board transfer devices 10a, 10b is transferring the board Sa or Sb thereon, nor is adjusting the width thereof, the controller 60 advances the control operation from Step 100 to Step 104 by way of Steps 101 to 103. At Step 104, the component placing head 43 of the component placing device 40 successively picks up designated components from the component supply devices 45a, 45b and successively mounts them at programmed coordinate positions on the boards Sa, Sb which are being held at the respective component mounting positions on the board transfer devices 10a, 10b.

[0079]

In the component mounting operations performed by the component placing head 43 of the component placing device 40, the components may be mounted alternately on the respective boards Sa, Sb. As shown in Figure 5 for example, this may be done in such a way that a component picked up from the second component supply device 45b is mounted on the board Sb held on the second board transfer device 10b, another component picked up from the first component supply device 45a is then mounted on the board Sa held on the first board transfer device 10a, another component picked up again from the second component supply device 45b is mounted on the board Sb, and next, another component picked up from the first component supply device 45a is mounted on the board Sa. Or, in the component mounting operations performed by the component placing head 43, the frequencies of mounting components on the respective boards Sa and Sb may be made to be different. As shown in Figure 7 for example, this may be done in such a way that the step of mounting on the board Sb a component picked up from the second component supply device 45b is performed once, the step of mounting on the board Sa another component picked up from the first component supply device 45a is repeated twice next, the step of mounting on the board Sb another component picked up again from the second component supply device 45b is performed once, and then, the step of mounting on the board Sa another component picked up from the first component supply device 45a is repeated twice. Although the rate in the component mounting frequency in the second example is such that the mounting on the board Sb and the mounting on the board Sa are 1: 2, it can be varied as desired by changing the number of repetition times through which the steps of mounting components on the same board in succession are performed.

[0080]

In the foregoing two examples, each component is picked up from the component supply device 45a, 45b closer to the board Sa, Sb on which it is to

be mounted. As the case may be, each component may be picked up from the component supply device far away from the board on which it is to be mounted. Or, the component mounting apparatus may be provided with one component supply device only, from which components may be picked up to be mounted on the both boards Sa, Sb.

[0081]

Returning to the operation according to the flow chart shown in Figure 24, when as shown in Figure 6, the second board transfer device 10b is transferring the boards Sb or is varying the width thereof, the controller 60 advances the control operation from Step 100 to Step 102 or 103 via Step 101 and further to Step 106. Since it cannot be done to mount components on the board Sb while the second board transfer device 10b is transferring the board Sb or is varying the width thereof, the component placing head 43 of the component placing device 40, at this Step 106, successively picks up designated components from the first component supply device 45a and mounts them one after another only on the board Sa held at the component mounting position on the first board transfer device 10a, as shown in Figure 6. In this manner, the component placing head 43 does not mount components on the board Sb, and instead, does mount components intensively on the board Sa held on the first board transfer device 10a. As a consequence, the time taken to mount the components on the board Sa during that time can be shortened, so that the mounting efficiency can be enhanced.

[0082]

Similarly, when the first board transfer device 10a is transferring the board Sa or is varying the width thereof, the controller 60 advances the control operation from Step 100 or 101 to Step 105. Also in this case, the component placing head 43 successively picks up designated components from the second component supply device 45b and mounts them one after another only on the

board Sb held at the component mounting position on the second board transfer device 10b. In this manner, the component placing head 43 does not mount components on the board Sa, and instead, does mount components intensively on the board Sb held on the second board transfer device 10b. As a result, the time taken to mount the components on the board Sb during that time can be shortened, so that the mounting efficiency can be enhanced.

[0083]

Although the foregoing first embodiment has been described in the case that the component placing device 40 is provided with a single component placing head, the first embodiment may be applicable to the component mounting apparatus of the type that the component placing device 40 is provided with two component placing heads 43a, 43b. In this case, when neither of the two board transfer devices 10a, 10b is performing the board transfer operation, nor is varying the width thereof, the respective component placing heads 43a, 43b respectively mount components in parallel time relation on the boards Sa, Sb held on the board transfer devices 10a, 10b associated therewith. On the other hand, when either one board transfer device 10a (or 10b) is performing the board transfer operation, or is varying the width thereof, the component placing head 43a (or 43b) associated therewith helps the component placing head 43b (or 43a) associated with the other board transfer device 10b (or 10a) and mounts components on the board Sb (or Sa) held on the other board transfer device 10b (or 10a). Also in this case, the time taken to mount the components on the board Sb (or Sa) can be shortened, so that the mounting efficiency can be enhanced. In this case, however, consideration has to be taken to obviate the physical interference between the two component placing heads with each other, as described hereinafter.

[0084]

As shown in Figures 1 and 8, in the case of the component mounting

apparatus provided with the two board transfer devices 10a, 10b, the two component supply devices 45a, 45b and the component placing device 40 with the two component placing heads 43, it is preferable from the viewpoints of reducing the feed distance of each component to be mounted as well as simplifying the control program, to make the first placing head 43a mount components mainly on the board Sa and to make the second placing head 43b mount components mainly on the board Sb. Also in this case, when the both component placing heads 43a, 43a stay within respective predetermined interference risk zones Si adjacent to the central portion between the both boards Sa and Sb, it becomes difficult to obviate the physical interference between the both placing heads 43a and 43b. The term "central portion" referred to here means the center of the point symmetry which is made by the both boards Sa, Sb stopped at the respective component mounting positions for component mountings, or where parts or all of edge portions of the both boards Sa, Sb are juxtaposed with each other, the term means the center line of the zone where the edge portions are juxtaposed. The term "predetermined interference risk zones Si" means the areas or zones defined on the boards Sa, Sb which the plane shapes of the component placing heads 43a, 43b cover outside or around the aforementioned center portion. Further, other parts on each of the boards Sa, Sb except for the interference risk zone Si is an interference-free zone. The embodiments devised to obviate the physical interference will be described hereafter.

[0085]

(Second Embodiment)

In the second embodiment shown in Figure 9, the two board transfer devices 10a, 10b have mutually different stop positions in the transfer direction to which the boards Sa, Sb are respectively stopped for component mounting operations thereon. The predetermined interference risk zones Si adjacent to

the central portion between the both boards Sa, Sb during the component mounting operations no longer exist where the respective stop positions are separated a suitable distance or longer. This can preclude the chance that the two component placing heads 43a, 43b interfere with each other in mounting components respectively on the boards Sa, Sb. Therefore, the efficiency in mounting components on the boards Sa, Sb can be enhanced, and at the same time, the program for controlling the operation of the component mounting apparatus can be simplified.

[0086]

(Third Embodiment)

In the aforementioned second embodiment, the interference of the two component placing heads 43a, 43b is obviated by devising the physical arrangement of the stop positions of the respective boards Sa, Sb. In the third embodiment for which Figures 10 and 25 respectively show a time chart and a flow chart, by devising the control program for the component mounting apparatus, the interference can be obviated without shifting the stop positions for the both boards Sa, Sb. On the assumption that, likewise as aforementioned, the first component placing head 43a mounts components mainly on the board Sa while the second component placing head 43b mounts components mainly on the board Sb, this third embodiment will be described hereinafter.

[0087]

At the beginning, when neither of the first and second component placing heads 43a, 43b is mounting any component within the interference risk zone Si on the board Sa, Sb corresponding thereto, the controller 60 advances its control operation from Step 110 to Step 112 via Step 111 in the flow chart shown in Figure 25. At Step 112, each component placing head 43a, 43b mounts a component within the interference-free zone on the board Sa, Sb held on each board transfer device 10a, 10b corresponding thereto. When the first

component placing head 43a performs the component mounting within the interference risk zone Si on the board Sa held on the first board transfer device 10a, the controller 60 advances the control operation from Step 110 to Step 113, whereby the second component placing head 43b mounts a component within the interference-free zone on the board Sb held on the second board transfer device 10b. Further, when the second component placing head 43b performs the component mounting within the interference risk zone Si on the board Sb held on the second board transfer device 10b, the controller 60 advances the control operation from Step 111 to Step 114, whereby the first component placing head 43a mounts a component within the interference-free zone on the board Sa held on the first board transfer device 10a. Therefore, it does not occur that the respective component placing heads 43a, 43b simultaneously mount components within the respective interference risk zones Si on the respective boards Sa, Sb, and there can be avoided such a chance that the two component placing heads 43a, 43b interfere with each other in performing the component mountings on the respective boards Sa, Sb.

[0088]

(Fourth Embodiment)

Also in the fourth embodiment shown in Figures 11, 12 and 26, the interference between the two component placing heads 43a, 43b is obviated by devising the control program for the component mounting apparatus, without shifting the positions of the both boards Sa, Sb. Next, the operation of the fourth embodiment will be described in accordance mainly with the flow chart shown in Figure 26.

[0089]

At the beginning, when neither of the both board transfer devices 10a, 10b is transferring the board Sa, Sb held thereon, nor is altering the width thereof, the controller 60 advances the control operation from Step 120 to Step

124 via Steps 121-123. At this Step 124, the respective component placing heads 43a, 43b of the component placing device 40 pick up components from the component supply devices 45a, 45b and mount them at designated coordinate positions within the interference-free zones on the respective boards Sa, Sb held on the both board transfer devices 10a, 10b.

[0090]

When the second board transfer device 10b is transferring the boards Sb as shown in Figure 12, or is altering the width thereof, the controller 60 advances the control operation from Step 120 to Step 122 or 123 via Step 121 and further to Step 126. At this Step 126, the first component placing head 43a successively picks up designated components from the first component supply device 45a and mounts them one after another at the designated positions within the interference risk zone Si on the board Sa held at the component mounting position on the first board transfer device 10a. Since no component mounting is performed on the board Sb while the second board transfer device 10b is transferring the boards Sb or is altering the width thereof, the second component placing head 43b may be made to flee to the position where it has no chance to interfere with the first component placing head 43a (refer to Figure 12). When so fleeing, the second component placing head 43b hardly interferes with the first component placing head 43a which is operating to mount components within the interference risk zone Si on the board Sa. Or, the second component placing head 43b may be directed to help the first component placing head 43a and to mount components within the interference risk zone Si on the board Sa. Upon so doing, the productivity of the boards Sa can be enhanced. In this latter case, the two component placing heads 43a and 43b have to be controlled to obviate the interference therebetween.

[0091]

Similarly, when the first board transfer device 10a is transferring the

boards Sa or is altering the width thereof, the controller 60 advances the control operation from Step 120 or 121 to Step 125, and the second component placing head 43b successively mounts components at designated positions within the interference risk zone Si on the board Sb held on the first board transfer device 10a. Also in this case, the first component placing head 43a which does not perform mounting the components on the board Sa is made to flee, so that it does not occur that the first component placing head 43a interferes with the second component placing head 43b which is mounting the components within the interference risk zone Si on the board Sb. Or, where the first component placing head 43a is directed to help the second component placing head 43b and to mount the components within the interference risk zone Si on the board Sb, the productivity of the boards Sb can be enhanced.

[0092]

The component mountings by the component placing heads 43a, 43b on the boards Sa, Sb in the second through fourth embodiments can be done in the same manner as described with reference to Figures 5-7 in the first embodiment. In the second through fourth embodiments, the components picked up from the first component supply device 45a are mounted on the board Sa, while the components picked up from the second component supply device 45b are mounted on the board Sb. However, as the case may be, the components picked up from the first component supply device 45a may be mounted on the board Sb, while the components picked up from the second component supply device 45b may be mounted on the board Sa. Moreover, the component mounting apparatus may be provided with one component supply device, and components may be picked up only from the component supply device to be mounted on the boards Sa, Sb.

[0093]

(Fifth Embodiment)

Next, the fifth embodiment shown in Figures 13 to 17 will be described. This embodiment uses a component mounting apparatus composed of the two board transfer devices 10a, 10b, the two component supply devices 45a, 45b and the component placing device 40 having the two component placing heads 43a, 43b. Table 1 below exemplifies one example of the process steps in the case of mounting components on the boards of three kinds shown therein.

[0094]

[TABLE 1]

Order of Production	Board Width (cm)	Number of Production
A	10	500
B	15	70
C	10	100

[0095]

With respect to the order of production, it is assumed that first of all, the productions of the two types of boards A and B are started by transferring the type-A boards on the first board transfer device 10a and at the same time, by transferring the type-B boards on the second board transfer device 10b, and that after completion of the type-B board production, two types of boards A and C are produced by transferring the type-C boards on the second board transfer device 10b and by continuing transferring the type-A boards on the first board transfer device 10a.

[0096]

In this case, prior to the production start, as shown in Figure 13, the respective conveyor width adjusting devices 30 are operated to set the width of the first board transfer device 10a to 10 centimeters and that of the second board transfer device 10b to 15 centimeters. Further, the feeders for the type-A board production are set on the feeder table of the first component supply

device 45a, the feeders for the type-B board production are set on the feeder table of the second component supply device 45b, and the feeders for the type-C board production are set on the feeder table of the second component supply device 45b. In the illustrated example, since the feeders for the type-C board production cannot be set all on the feeder table of the second component supply device 45b, some of them are also set on the feeder table of the first component supply device 45a.

[0097]

In the production, as shown in Figure 14, the first board transfer device 10a successively loads the type-A boards, and the first component placing head 43a (not shown) successively mounts components. In parallel time relation with this, the second board transfer device 10b successively loads the type-B boards, and the second component placing head 43b (not shown) successively mounts components. In order to obviate the physical interference between the both component placing heads 43a and 43b within the interference risk zones Si on the both boards Sa, Sb, the stop positions of the respective boards Sa, Sb in the transfer directions may be set to be different from each other (refer to Figure 9).

[0098]

After completion of the type-B board production, as shown in Figure 15, the width of the second board transfer device 10b is altered by the conveyor width adjusting device 30 for the second board transfer device 10b from 15 centimeters to 10 centimeters in parallel time relation with the component mountings on the type-A boards. During the alteration operation, the second component placing head 43b may be retracted to a shunting or turnout position. However, if the second component placing head 43b is caused to help the first component placing head 43a and to mount the components on the type-A boards, the productivity can be heightened. In this latter case, the two

component placing heads 43a and 43b have to be controlled to obviate the interference therebetween.

[0099]

Upon termination of altering the width of the second board transfer device 10b, as shown in Figure 16, the mountings by the second component placing head 43b of the components are performed on the type-C boards successively loaded by the second component transfer device 10b, in parallel time relation with the mountings by the first component placing head 43a of the components on the type-A boards. Where the feeders for the components to be mounted on the type-C boards have been set on the feeder table on the side of the first component supply device 45a, the chance for the both component placing heads 43a and 43b to interfere with each other increases, and therefore, measures have to be taken to obviate the interference. To cope with this, in the illustrated embodiment, the stop positions of the respective boards Sa, Sb are made to be different from each other, and the feeders for the type-A boards and those for the type-C boards which are set on the feeder table of the first component supply device 45a are arranged with some space therebetween. If the measures are imperfect, as shown in Figure 17, a control is executed, for example, to move the first component placing head 43a temporally to a turnout position when the second component placing head 43b is about to pick up the components from the feeders on the side of the first component supply device 45a. The control to obviate the interference becomes unnecessary after termination of the type-A board production.

[0100]

Where the boards of a different type are to be produced in succession to the termination of the type-A board production on the first board transfer device 10a, the first component placing head 43a is caused to wait at the turnout position or to help the second component placing head 43b and to

mount the components on the type-C boards until such a board is loaded onto the first board transfer device 10a. Also when the programmed production schedule is completed, the first component placing head 43a is caused to wait at the turnout position or to help the second component placing head 43b and to mount the components on the type-C boards.

[0101]

(Sixth Embodiment)

Next, the sixth embodiment shown in Figures 18 and 27 will be described. This embodiment uses a component mounting apparatus composed of the two board transfer devices 10a, 10b, the two component supply devices 45a, 45b and the component placing device 40 including one or two component placing heads 43 or 43a, 43b. Of the two board transfer devices 10a, 10b, one of them is set as exclusive use for regular type products for transferring boards of the regular type products only, while the other is set as use for break-in products for transferring boards of the break-in products which are different in board width.

[0102]

Where a schedule has been set that a plurality of the type-A products are to be produced, a command to produce the type-B products on an urgent, break-in basis may be input to the controller 60 from the host computer. In such a case, if the two board transfer devices 10a, 10b were all rearranged to be switched from the production of the regular type products to the production of the break-in product, much loss time would be taken to make the rearrangement. In particular, where the number of the break-in products to be produced is small, the loss time would become much larger if two board transfer devices were rearranged.

[0103]

In order to reduce the loss time taken to make the rearrangement, one

of the two board transfer devices 10a, 10b is set as exclusive use for regular type products for transferring the boards of the regular type products only, while the other device is set as use for break-in products for transferring the boards of the break-in products which are different in board width. As setting means for making this setting, for example, the memory unit 63 is provided, for the respective board transfer devices 10a, 10b, with setting areas in which "1" is set when a board transfer device is to be set as exclusive use for the regular type products while "0" is set when it is to be set as use for the break-in products. For example, where the board transfer devices 10a and 10b are to be set respectively as exclusive use for the regular type products and as use for the break-in products, "1" and "0" are input from the input unit 64 of the controller 60 to the setting areas for the board transfer devices 10a, 10b. And, the feeders retaining the components for the regular type products are all set in the component supply device 45a on the side of the board transfer device 10a, while vacant slots for use in setting the feeders retaining the components for the break-in products are left in the component supply device 45a on the side of the board transfer device 10b.

[0104]

When a command for production of the break-in products (type-B products) is input from the host computer to the controller 60 (Step 132) in the course of the ordinary production wherein the boards for the regular type products (type-A boards) are transferred on the board transfer devices 10a, 10b and wherein the regular type products (type-A products) are under the ordinary production (Step 131), the board transfer device 10b prepared for the break-in products stops loading a type-A board and performs the processing to discharge a type-A board thereon (Step 133). The mounting program for mounting components on the board transferred by the board transfer device 10b to the component mounting position is changed from a type-A product

mounting program to a type-B product mounting program (Step 134). Then, the width of the board transfer device 10b in a direction perpendicular to the transfer direction is altered to meet a rail width corresponding to the type-B boards (Step 135). Thereafter, it is judged whether or not, the component mountings on the type-A boards at the board transfer device 10a and the component mountings on the type-B boards at the board transfer device 10b cause the interference between the component placing heads 43a, 43b so that such simultaneous mountings are impossible (Step 136). If possible, the component mountings on the type-A boards at the board transfer device 10a and the component mountings on the type-B boards at the board transfer device 10b are carried out simultaneously (Step 137). Where the simultaneous productions are impossible, the component mountings at the board transfer device 10a are halted, during which time the component mountings on the type-B boards are carried out at the board transfer device 10b until the number of the type-B boards reaches a commanded number (Step 138). When the component mountings on the type-B boards of the commanded number are completed (Step 139), the board transfer device 10b is restored to the production for the type-A products, and the type-A products are produced as ordinary on the board transfer devices 10a, 10b.

[0105]

(Seventh Embodiment)

Next, the seventh embodiment shown in Figures 19 and 20 will be described. In this embodiment, where the boards on which the component mountings are to be carried out at the board transfer devices are changed from the first type product boards (type-A boards) to the second type product boards (type-B boards), component mountings on a trial basis are carried out on the changed boards at the board transfer devices, and unless any problem is given rise to, mounting operations on a full-scale basis are started. Where the

component mountings on the type-B boards are started immediately after the component mountings on the type-A boards are completed at the board transfer devices, it is often the case that the type-B boards with the components so mounted thereon have defects in quality. This gives rise to faulty products and a time loss in production. Therefore, it has been a practice in production sites that prior to such change in production, prior trial mountings of components are performed on the type-B boards at the board transfer device which is to be used after the change in production. However, taking into account the facts that the condition of the component mounting apparatus changes as time expires long after the trial mountings and that reconfirmation has to be made as to whether the feeders necessary for mounting components on the type-B boards have been set on the component supply devices, it is preferable to perform the trial basis mountings right before the initiation of component mountings on the type-B products. To this end, by taking the advantage that the component mounting apparatus is provided with the two board transfer devices 10a, 10b, component mountings on a trial basis are performed on the type-B boards at one board transfer device in parallel time relation with component mountings on the type-A boards at the other board transfer device.

[0106]

As shown in Figure 19 for example, it is now assumed that the board transfer device 10a has been set as exclusive use for the regular type products, while the board transfer device 10b has been set as use for the break-in products and that one-side production is being performed wherein the full-scale basis production of boards (type-A boards) for the first regular type products is carried out at the board transfer device 10a, while no component mounting operation is being carried out at the board transfer device 10b. It is further assumed that while the preceding one-side production is being carried out, another one-side production is further commanded for performing component

mountings on the boards (type-B boards) for the second regular type products. In this case, there is set a mounting program for performing component mounting operations on the type-B boards at the board transfer device 10b, and the rail width of the board transfer device 10b is altered to correspond to the type-B boards. Thus, the full-scale basis mountings of components are performed on the type-A boards at the board transfer device 10a, and the trial basis mountings of components are performed on the type-B boards at the board transfer device 10b. Where the change from the first regular type products to the second regular type products has been determined in dependence upon the production schedule, the timing when the trial basis component mountings are to be started is determined taking into account the progress in production of the first regular type products, the time period for the trial basis production of the second regular type products and the time period necessary for inspection and correction. Where the change to the second regular type products is suddenly instructed, the trial basis component mountings on the boards for the second regular type products are started at the time point at which the change command is given. The type-B board with components mounted thereon is unloaded from the board transfer device 10b and is inspected. The inspection is carried out with respect to such items as mounting position, components, setting error of feeders, mounting accuracy and so on. If any problem arises as a result of the inspection, corrections concerning such faulty items are made for the adjustment in component mountings on the type-B boards at the board transfer device 10b, the change in the set feeders and the like. After the problems are all solved, the component mountings on the type-B boards are started on the full-scale basis at the board transfer device 10b, and the component mountings on the type-A boards at the board transfer device 10a are terminated when a scheduled number is attained. Thereafter, in order that the setting change is performed to set the board

transfer device 10b as exclusive use for the regular type products and the board transfer device 10a as use for the break-in products, "0" and "1" are inputted from the input device 64 respectively to the setting areas for the board transfer devices 10a, 10b of the memory unit 63 of the controller 60.

[0107]

It is now assumed that as shown in Figure 20, the both-side productions are being performed to mount components on the boards (type-A boards) for the first regular type products at the board transfer device 10a, 10b on a full-scale basis wherein the board transfer device 10a has been set as exclusive use for the regular type products while the board transfer device 10b has been set as use for the break-in products. When in this state, another both-side production command is given for mounting components on the boards (type-B boards) for the second type products on a full-scale basis, the board transfer device 10b stops loading a further type-A board thereto and unloads the type-A board thereon in order that the trial basis mountings of components on the type-B boards can be done at the board transfer device 10b. The mounting program for component mountings at the board transfer device 10b is changed from the mounting program for the type-A boards to that for the type-B boards, and the rail width of the board transfer device 10b is adjusted to correspond to the type-B boards. The component mounting operations are carried out on the type-A boards at the board transfer device 10a on the full-scale basis and on the type-B boards at the board transfer device 10b on the trial basis. The type-B boards each with components mounted thereon are unloaded from the board transfer device 10b and are inspected. If any problem arises as a result of the inspection, corrections are made concerning the faulty items, and the component mountings are carried out on the type-B boards at the board transfer device 10b on the full-scale basis. Then, when the type-A boards with the components mounted at the board transfer device 10a reach the scheduled

number, the component mountings of the type-B boards on the trial basis are performed at the board transfer device 10a in the same manner as done at the board transfer device 10b, and the component mountings on the type-B boards on the full-scale basis are started after any problem is found out and solved.

[0108]

(Eighth Embodiment)

Next, the eighth embodiment will be described. This embodiment uses a component mounting apparatus composed of the two board transfer devices 10a, 10b, the two component supply devices 45a, 45b and the component placing device 40 including the two component placing heads 43a, 43b, and aims at decreasing the chance for the two component placing heads 43a, 43b to interfere in performing the both-side productions.

[0109]

As shown in Figures 2 and 21, the two board transfer devices 10a, 10b are juxtaposed for transferring the boards in the respective directions parallel to each other, and the two components supply devices 45a, 45b are arranged respectively at the outsides opposite to the center side where the board transfer devices 10a, 10b adjoin to each other. The board transfer devices 10a, 10b are provided with respective pairs of the guide rails 25a, 26a and 25b, 26b each pair for guiding both sides of the board. The support rails 20 and the side rails 14 which constitute the outside guide rails 25a, 25b respectively adjacent to the component supply devices 45a, 45b are secured to the outside support pedestals 12, 12 upright fixed on the base 11. The support rails 20 and the side rails 14 which constitute the center side guide rails 26a, 26b are secured to the inside support pedestals 12a, 12a which are supported and guided on the base 11 each for position adjustment in the direction perpendicular to the direction in which the guide rails extend. The inside support pedestals 12a are movable respectively by the first and second drive motors 33, 37 through the first and

second screw shafts 31, 35 in accordance with the commands from the controller 60, so that the center side guide rails 26a, 26b are adjusted in position in the direction perpendicular to the lengthwise directions thereof to alter the rail widths of the board transfer devices 10a, 10b in correspondence to the widths of the boards. The guide rail position adjusting means 27 for adjusting the positions of the center side guide rails 26a, 26b in a direction perpendicular to the lengthwise direction is composed of the inside support pedestals 12a, the first and second drive motors 33, 37, the first and second screw shafts 31, 35, the controller 60 and the like. Thus, where the width between the two guide rails 25a, 26a or 25b, 26b is adjusted to be narrow, an extra space is made between the movable guide rails 26a and 26b which are on the center side of the respective board transfer devices 10a, 10b. This extra space results in separating the two boards, so that the chance for the component placing heads 43a, 43b to interfere can be minimized.

[0110]

In the same manner as the inside support pedestals 12a are done, the outside support pedestals 12 may be slidably guided on the base 11 for position adjustment and may be movable by drive servomotors through screw shafts thereby to make the outside guide rails 25a, 25b adjustable by the position adjusting means 27 in the direction perpendicular to the lengthwise direction of the guide rails. In this case, it become realized to make an extra space at the center side of the respective board transfer devices 10a, 10b by positioning, through controls, the outside guide rails 25a, 25b at the outmost positions respectively closest to the component supply devices 45a, 45b and by adjusting the center side guide rails 26a, 26b to set the rail widths of the board transfer devices 10a, 10b in correspondence to the widths of the boards transferred therealong, so that the chance for the component placing heads 43a, 43b to interfere can be minimized. In this case, a prior judgment is made

of whether or not, any feeder for the components to be mounted on the boards transferred by the board transfer devices 10a, 10b has been set also in the component supply device 45b, 45a located at the remote side, and only in the case that any such feeder has been set only in the component supply device 45b, 45a located at the closer side, the outside guide rails 25a, 25b are controlled to be positioned closest to the component supply devices 45b, 45a as mentioned earlier, whereby it becomes realized to shorten the moving distances of the component placing heads 43a, 43b and to obviate the interference therebetween.

[0111]

Hereinafter, a component mounting system which employs the component mounting apparatus described with reference to Figures 1 to 4 for a production line will be described in the ninth and tenth embodiments.

[0112]

(Ninth Embodiment)

In the component mounting system of the ninth embodiment, as shown in Figure 22, there is used a production line (or a part thereof), wherein two mounting stations 50, 51 each comprising the aforementioned component mounting apparatus are arranged in series, and wherein a first shifting device 52 is arranged at the loading side of the first mounting station 50, while a second shifting device 53 is arranged at the unloading side of the second mounting station 51. The first shifting device 52 is provided with first and second entrance side board transfer devices 52a, 52b each having the same conveyor width adjusting device 30 as provided to the board transfer devices 10a, 10b, and the second shifting device 53 is provided with first and second exit side board transfer devices 53a, 53b respectively having the same configurations as the first and second entrance sides board transfer devices 52a, 52b. The first entrance side board transfer device 52a of the first shifting

device 52, the first board transfer devices 10a of the two mounting stations 50, 51 and the first exit side board transfer device 53a of the second shifting device 53 are connected in series in the longitudinal direction, with the respective widths being kept by the conveyor width adjusting devices 30 associated thereto in coincidence with one another. Similarly, the second entrance side board transfer device 52b, two second board transfer devices 10b and the second exit side board transfer device 53b are connected in series in the longitudinal direction, with the respective widths being kept in coincidence with one another. Thus, the respective boards are movable successively on the respective board transfer devices 52a, 10a, 10a and 53a on one side and on the respective board transfer devices 52b, 10b, 10b and 53b on the other side independently of each other. Because the first and second board transfer devices 10a, 10b are adjusted to bring their widths into coincidence, each board can be loaded by the first shifting device 52 selectively into the first and second board transfer devices 10a, 10b and can be unloaded by the second shifting device 53 to merge into the first exit side board transfer device 53a.

[0113]

In accordance with a command from the controller 60, the first shifting device 52 classifies the boards Sa, Sb of plural kinds which are loaded from a preceding production station onto the first entrance side board transfer device 52a, into the boards Sa to be sent onto the first board transfer device 10a and those Sb to be sent onto the second board transfer device 10b and feeds the former, as they are, onto the first board transfer device 10a of the first mounting station 50 and the latter onto the second board transfer device 10b of the first mounting station 50 after shifting them to the second entrance side board transfer device 52b. The first shifting device 52 is provided with an entrance side shifting mechanism (represented by an arrow of the shape "N" and omitted from being described in detail in construction) for performing such

shifting motion. Although in Figure 22, the boards from the preceding production station are illustrated to be loaded on the first entrance side board transfer device 52a, they may be loaded on the second entrance side board transfer device 52b or may be loaded on both entrance side board transfer devices 52a, 52b, in which case the entrance side shifting mechanism may be a little different in specific function and construction.

[0114]

In accordance with a command from the controller 60, the second shifting device 53 selects those boards which are still to have components mounted thereon continuously, from the respective boards Sa, Sb loaded from the mounting stations 50, 51 onto the exit side board transfer devices 53a, 53b and shifts such those boards onto the first exit side board transfer device 53a to transfer them to a succeeding mounting station. The second shifting device 53 shifts those boards with which the component mounting operations have been completed, onto a board discharge device 54 and discharges them. The second shifting device 53 includes an exit side shifting mechanism (represented by an arrow of the shape "N" and omitted from being described in detail in construction) for performing such shifting motion.

[0115]

The production line in this ninth embodiment operates upon selection of either one of first and second production modes as described hereinafter. In the first production mode, the first shifting device 52 classifies the boards Sa, Sb of plural kinds loaded from the preceding production station onto the first entrance side board transfer device 52a, into the boards Sa on which component are to be mounted at the first board transfer devices 10a of the respective mounting stations 50, 51 and into those Sb on which component are to be mounted at the second board transfer devices 10b of the respective mounting stations 50, 51, and feeds the former into the first board transfer device 10a of the first

mounting station 50 and the latter into the second board transfer device 10b of the first mounting station 50. The respective boards Sa, Sb have components mounted thereon by the component mounting apparatus of the respective mounting stations 50, 51 and are sent out to the exit side board transfer devices 53a, 53b of the second shifting device 53. Those boards Sa, Sb on which the component mountings are further required are transferred from the first exit side board transfer device 53a onto the succeeding mounting station; while other boards Sa, Sb on which the component mountings have been completed are discharged from the board discharge device 54.

[0116]

Further, in the second production mode, the first shifting device 52 classifies the boards Sa, Sb of plural kinds loaded from the preceding production station onto the first entrance side board transfer device 52a, into the boards Sa on which component are to be mounted at the first board transfer devices 10a of the respective mounting stations 50, 51 and into those Sb on which any component is not to be mounted at the respective mounting stations 50, 51, and feeds the former onto the first board transfer device 10a of the first mounting station 50 and the latter onto the second board transfer device 10b of the first mounting station 50. The boards Sa have components mounted thereon at the first board transfer devices 10a of the respective mounting stations 50, 51 and are sent out to the first exit side board transfer device 53a of the second shifting device 53. The boards Sb are fed by the respective second board transfer devices 10b to pass through the respective component mounting apparatus of the respective mounting stations 50, 51 without being stopped thereat and are sent out to the second exit side board transfer device 53b of the second shifting device 53. And, in the same way as the first production mode, the boards Sa, Sb on which the component mountings are further required are unloaded from the first exit side board

transfer device 53a to the succeeding mounting station, while the boards Sa, Sb on which the component mountings have been completed are discharged from the board discharge device 54. In this second production mode, the second board transfer devices 10b of the both mounting stations 50, 51 are utilized as bypass conveyor for enabling the boards Sb on which any component is not mounted at the first board transfer devices 10a, to bypass the same.

[0117]

In the first production mode of the ninth embodiment, even where the boards Sa, Sb of plural kinds are loaded in a random order, the respective boards Sa, Sb can be automatically fed to the corresponding board transfer devices 10a, 10b and can have components mounted thereon by the respective component mounting apparatus, so that flexibility can be increased in the production of the boards. Further, in the second production mode, the boards on which the component mounting is unnecessary at a certain mounting station can bypass such a certain mounting station to be sent forward. Thus, it does not take place that the boards are caused to remain stopped in the mid course of the production line, so that the productivity of the boards can be enhanced.

[0118]

Furthermore, in a production line connecting plural component mounting apparatus in series as shown in Figure 22, it is often the case that when the component placing device 40 of a certain component mounting apparatus runs into difficulties, the production line usually falls in shutdown as a whole. However, if the second production mode is applied to the component mounting apparatus running into the difficulties in the production line, thereby to cause the boards to bypass the troubled apparatus, the component mounting operations can be done in other component mounting apparatus than the component mounting apparatus, so that it does not take place to bring the

entirety of the production line into shutdown. Then, where mounting is then performed with the components which were not able to be mounted by the component mounting apparatus so troubled, the board can be corrected within a relatively short time and can be made to a finished product.

[0119]

(Tenth Embodiment)

Next, the tenth embodiment shown in Figure 23 will be described. This embodiment is constituted by modifying the ninth embodiment so that the first shifting device 52 arranged at the loading side of the first mounting station 50 is replaced by a shifting device 55, that the second shifting device 53 is replaced by a shifting device 56 with an inspection station and that the board transfer device 10b is additionally given a function for returning the boards from the second exit side board transfer device 56b to the second entrance side board transfer device 55b.

[0120]

The shifting device 55 takes almost the same configuration as the first shifting device 52, but in addition to the function of the aforementioned first shifting device 52, is further given another function for shifting the boards which were returned from the shifting device 56 with the inspection station via the second board transfer devices 10b of the both mounting stations 50, 51 to the second entrance side board transfer device 55b, to the first entrance side board transfer device 55a and for sending the returned boards to the first board transfer device 10a of the first mounting station 50.

[0121]

The shifting device 56 with the inspection station has almost the same construction as the second shifting device 53 in the ninth embodiment. In addition to the foregoing function of the second shifting device 53, the shifting device 56 is given another function for inspecting the boards Sa loaded onto

the first exit side board transfer device 56a from the mounting stations 50, 51, transferring to the second board transfer device 10b any board Sa which lacks some components but is able to remount the same, and transferring to the board discharge device 57 any board Sa which lacks some components but is no longer able to remount the same.

[0122]

The production line in this tenth embodiment is operated selectively in two of first and second production modes, as described hereinafter. First of all, in the first production mode, in the same manner as the foregoing ninth embodiment operates in the first production mode, the shifting device 55 classifies the boards Sa, Sb of plural kinds loaded from the preceding production station onto the first entrance side board transfer device 55a, into two groups and sends the groups respectively to the first board transfer device 10a and the second board transfer device 10b of the first mounting station 50. The respective boards Sa, Sb have components mounted thereon by the component mounting apparatus of the respective mounting stations 50, 51 and then, are sent out to the exit side board transfer devices 56a, 56b of the shifting device 56 with the inspection station. The boards Sa, Sb on which components are further to be mounted are unloaded from the first exit side board transfer devices 56a to the succeeding mounting station, while other boards Sa, Sb on which the component mountings have been completed are discharged from the board discharge device 57.

[0123]

Further, in the second production mode, the shifting device 55 sends all of the boards Sa loaded from the preceding production station onto the first entrance side board transfer device 52a, to the first board transfer device 10a of the first mounting station 50. The shifting device 56 with the inspection station inspects the boards Sa which are loaded to the first exit side board

transfer devices 56a after having components mounted thereon at the first board transfer devices 10a of the respective mounting stations 50, 51. The shifting device 56 returns any board which lacks some components but is able to remount the same, to the second board transfer device 10b, while it transfers any defective board which lacks some components and is unable to remount the same, to the board discharge device 57. The defective board having been shifted to the board discharge device 57 is discharged as it is. The board having been shifted to the second board transfer device 10b is returned as board Sb to the second entrance side board transfer device 55b by way of the second board transfer devices 10b of the respective mounting stations 51, 50 without being stopped in the course of such return feeding, and component lacking information concerning the board Sb is inputted to the controller 60. The board Sb returned to the second entrance side board transfer device 55b is shifted by the shifting device 55 controllable by the controller 60, onto the first entrance side board transfer device 55a and is sent in turn onto the first board transfer devices 10a of the both mounting stations 50, 51, whereby the components which were lacked are automatically remounted in accordance with the component lacking information having been input to the controller 60. In this second production mode, the second board transfer devices 10b of the both mounting stations 51, 50 are used as return conveyor for returning the defective boards Sb from the shifting device 56 with the inspection station to the shifting device 55.

[0124]

In the first production mode of this tenth embodiment, flexibility can be increased in the production of the boards, as is true in the first production mode of the ninth embodiment. In the second production mode, on the other hand, where the curable lack of any component occurs on the board Sa that is sent to the shifting device 56 with the inspection station after having

components mounted at the first board transfer devices 10a of the respective mounting stations 50, 51, such component lack can be automatically detected at the shifting device 56 with the inspection station, and the board Sa is returned by the second board transfer devices 10b to the shifting device 55 preceding the mounting stations 51, 50, so that any lacked component can automatically be remounted on the board Sa. Accordingly, because it becomes unnecessary to especially remount the lacked component after completion of the component mountings by the production line, the production control coping with the lacking of components can be simplified.

[0125]

Although in the aforementioned sixth and tenth embodiments, the component placing heads 43a, 43b of the component placing device 40 are exemplified as being of the XY type that they are movable in two directions parallel to the surface of each board Sa, Sb, the two embodiments are not restricted to take this configuration and are also applicable to a component mounting apparatus which employs a turret-type component placing head.

[0126]

In each of the foregoing embodiments, the two board transfer devices 10a, 10b are provided on each of the component mounting apparatus. With this configuration, the width of each board transfer device 10a, 10b can be altered each time the last board in one lot passes through the board mounting apparatus, so that the waiting time for the production start of boards in a next lot can be shortened. However, the present invention is not limited to this configuration. It is also possible to practice the present invention in the form that the board transfer devices are configured as those extending over the entire production line.

[Brief Description of the Drawings]

[Figure 1]: a plan view showing the general construction of a component

mounting apparatus according to the present invention.

[Figure 2]: an enlarged section of first and second board transfer devices taken along the line 2-2 in Figure 1.

[Figure 3]: a line 3-3 section in Figure 2.

[Figure 4]: a block diagram showing a control system of the electronic component mounting apparatus shown in Figure 1.

[Figure 5]: a rough plan view explaining the operation in the first embodiment according to the present invention.

[Figure 6]: a rough plan view explaining the operation in the first embodiment according to the present invention.

[Figure 7]: a rough plan view explaining the operation in the first embodiment according to the present invention.

[Figure 8]: a view showing interference risk zones within which first and second component placing heads have a risk to interfere.

[Figure 9]: a rough plan view explaining the operation in the second embodiment according to the present invention.

[Figure 10]: a time chart explaining the operation in the third embodiment according to the present invention.

[Figure 11]: a time chart explaining the operation in the fourth embodiment according to the present invention.

[Figure 12]: a rough plan view explaining the operation in the fourth embodiment according to the present invention.

[Figure 13]: a rough plan view explaining the operation in the fifth embodiment according to the present invention.

[Figure 14]: a rough plan view explaining the operation in the fifth embodiment according to the present invention.

[Figure 15]: a rough plan view explaining the operation in the fifth embodiment according to the present invention.

[Figure 16]: a rough plan view explaining the operation in the fifth embodiment according to the present invention.

[Figure 17]: a rough plan view explaining the operation in the fifth embodiment according to the present invention.

[Figure 18]: a rough plan view showing the sixth embodiment according to the present invention.

[Figure 19]: a chart explaining a trial basis mounting state in a one-side production in the seventh embodiment according to the present invention.

[Figure 20]: a chart explaining a trial basis mounting state in a both-side production in the seventh embodiment according to the present invention.

[Figure 21]: a rough plan view showing the eighth embodiment according to the present invention.

[Figure 22]: a rough plan view explaining the operation in the ninth embodiment according to the present invention.

[Figure 23]: a rough plan view explaining the operation in the tenth embodiment according to the present invention.

[Figure 24]: a flow chart explaining the operation in the first embodiment according to the present invention.

[Figure 25]: a flow chart explaining the operation in the third embodiment according to the present invention.

[Figure 26]: a flow chart explaining the operation in the fourth embodiment according to the present invention.

[Figure 27]: a flow chart explaining the operation in the sixth embodiment according to the present invention.

[Designation of Symbols]

10a, 10b...board transfer devices; 25a, 25b...outside guide rails; 26a, 26b...center side guide rails; 30...conveyor width adjusting devices; 40...component placing device; 41, 42a, 42b...head placing mechanisms

(fixed rails, head moving rails); 43a, 43b...component placing heads; 45a, 45b...component supply devices; 52...first shifting device; 55...shifting device; 56...shifting device with inspection station; 60...controller; 63...memory unit; 64...input unit; Sa, Sb...boards; Si...interference risk zones

[Document Name] ABSTRACT

[Summary]

[Problem] To enhance the productivity in mounting components on a board, to prevent the entirety of a production line from falling in shutdown due to a local failure, and to simplify a production control in the event of remounting components.

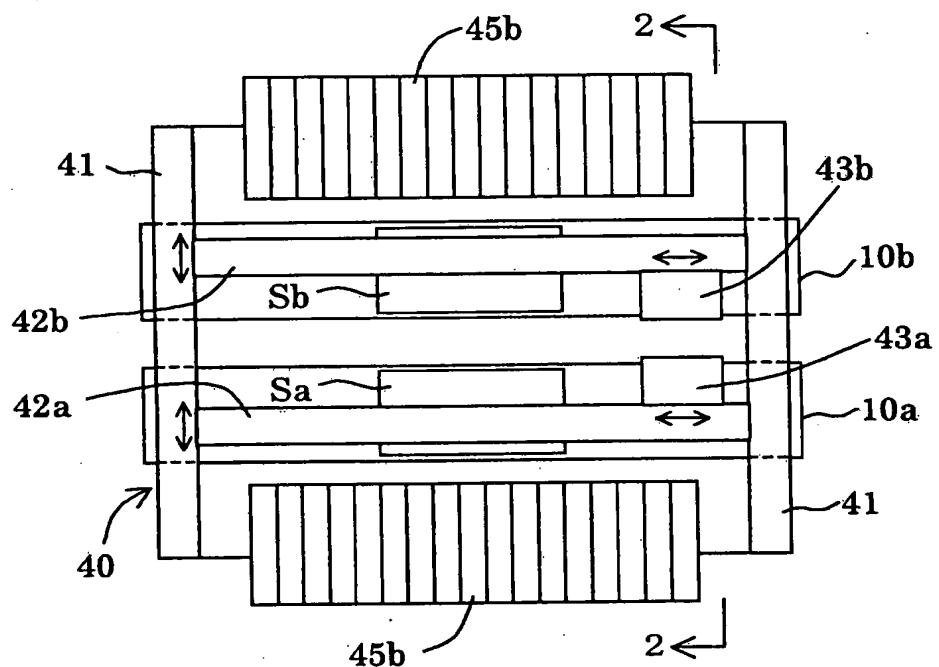
[Solution] Two component placing heads 43a, 43b pick up components from two component supply devices 45a, 45b and mount the picked-up components on boards Sa, Sb loaded respectively by two board transfer devices 10a, 10b. A component placing device mounts components simultaneously or alternately on two boards loaded by the two board transfer devices. In the case of two component placing heads, when one of the boards is being transferred or when the board transfer device for transferring the one board is being adjusted to alter its width, the component placing head for performing component mountings on the one board helps the other component placing head and performs component mountings on the other board. Either one of the board transfer devices may be utilized as bypass conveyor or return conveyor.

[Selected Drawing] Figure 24

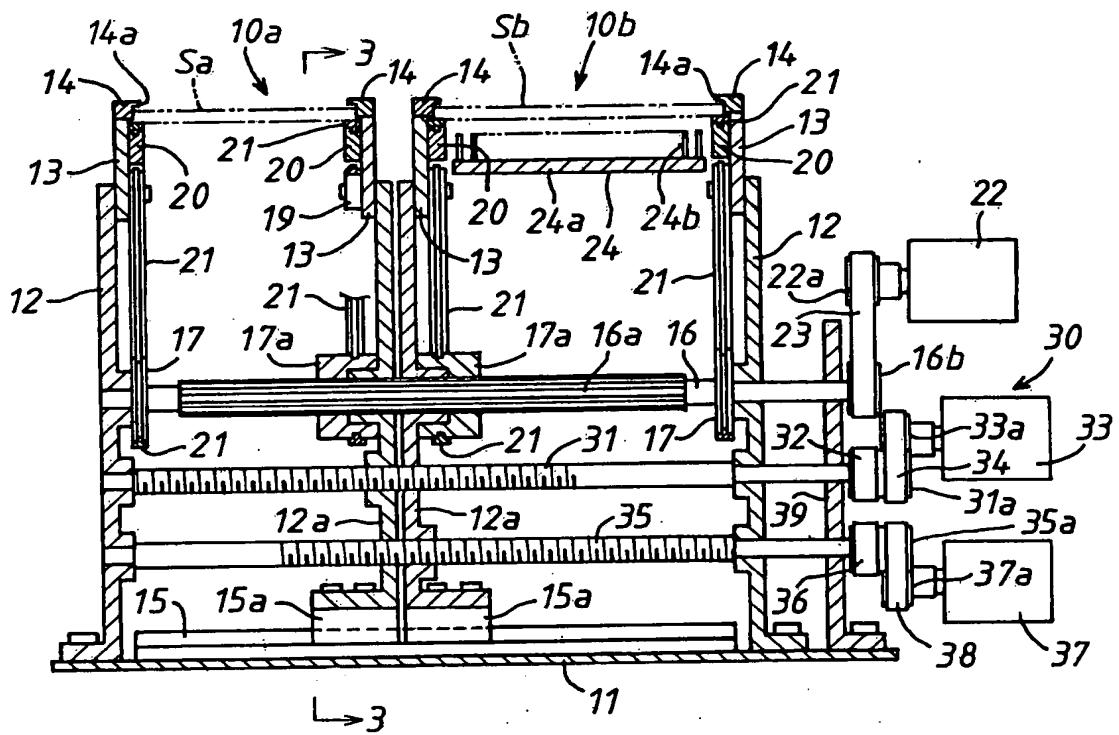


[Document Name] DRAWINGS

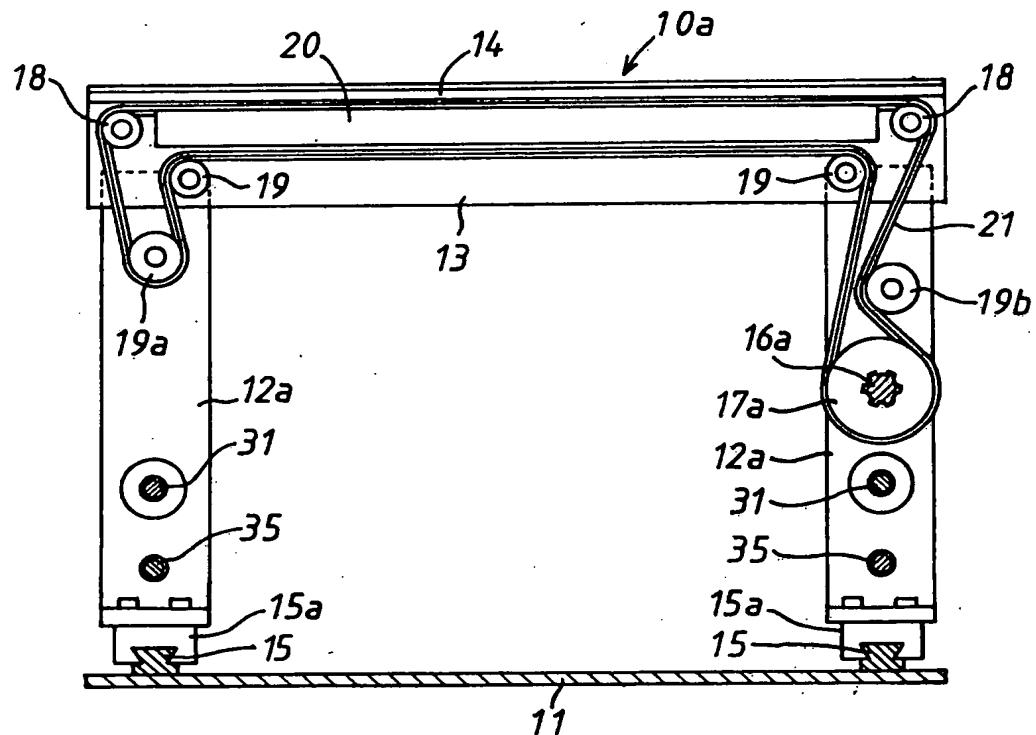
[FIG. 1]



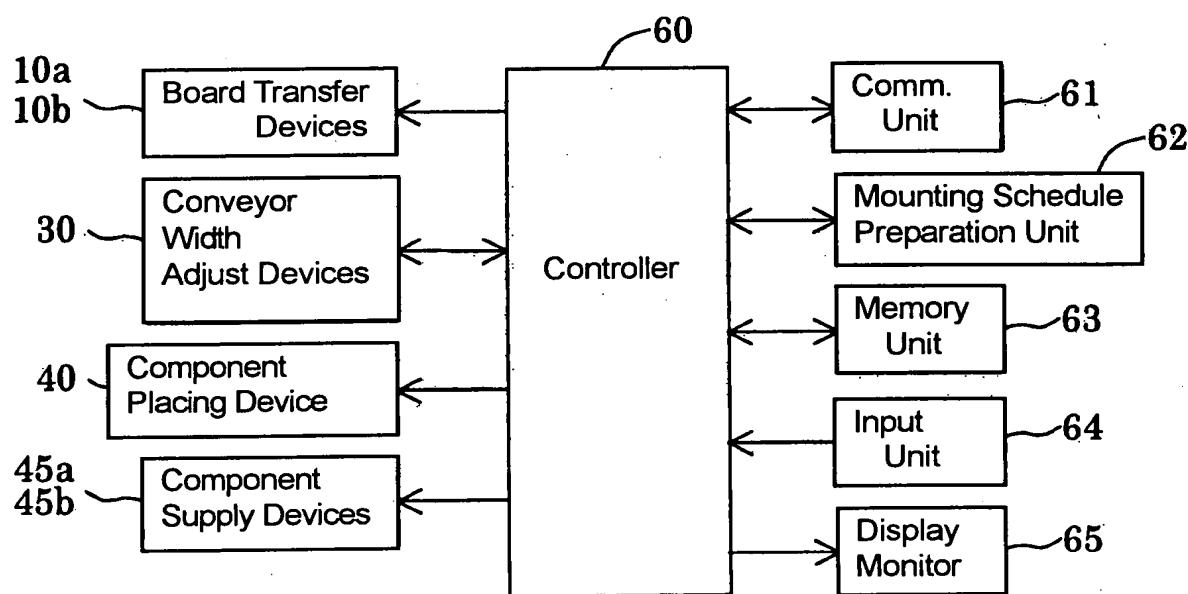
[FIG. 2]



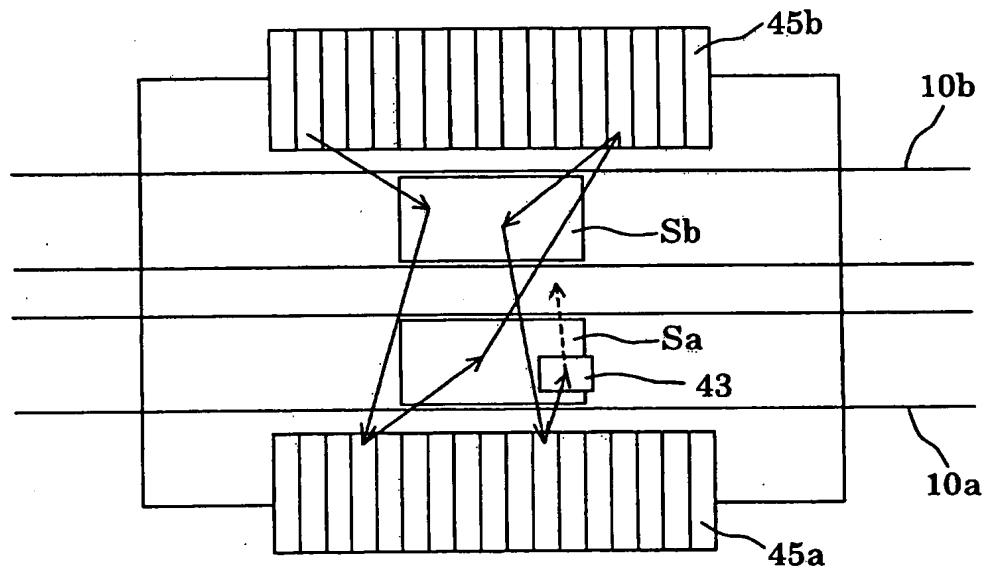
[FIG. 3]



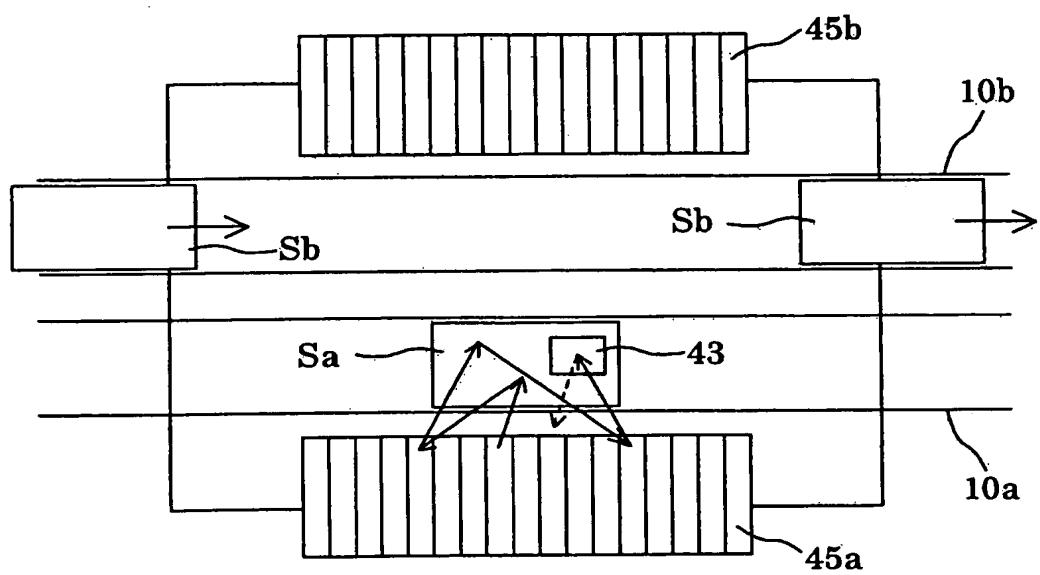
[FIG. 4]



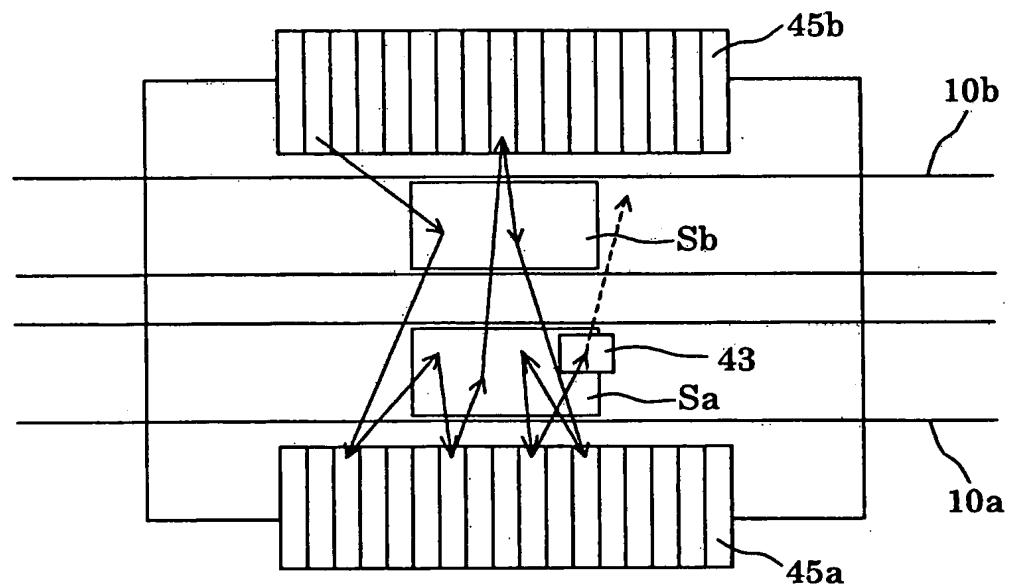
[FIG. 5]



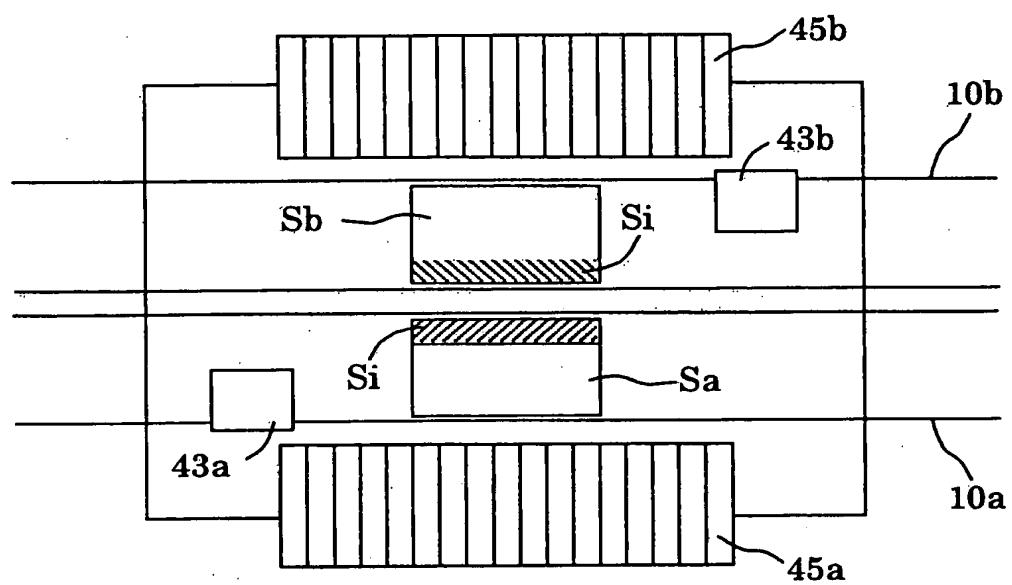
[FIG. 6]



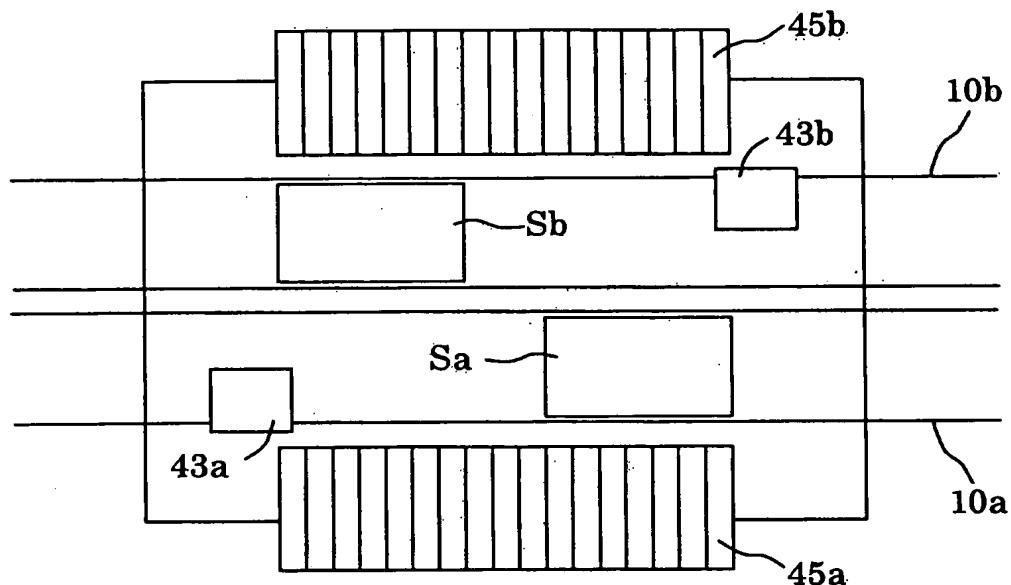
[FIG. 7]



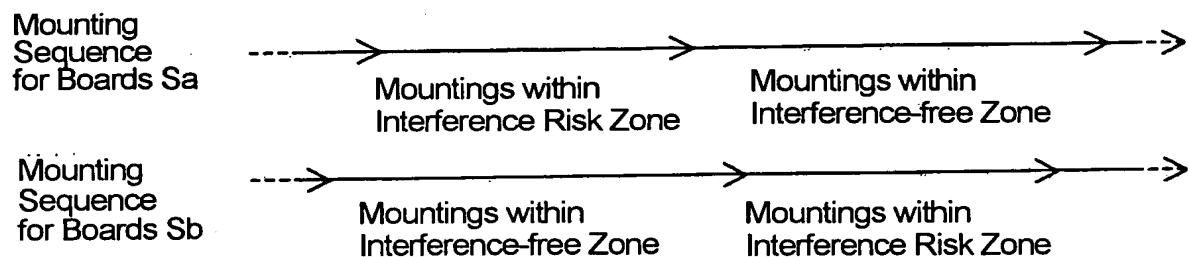
[FIG. 8]



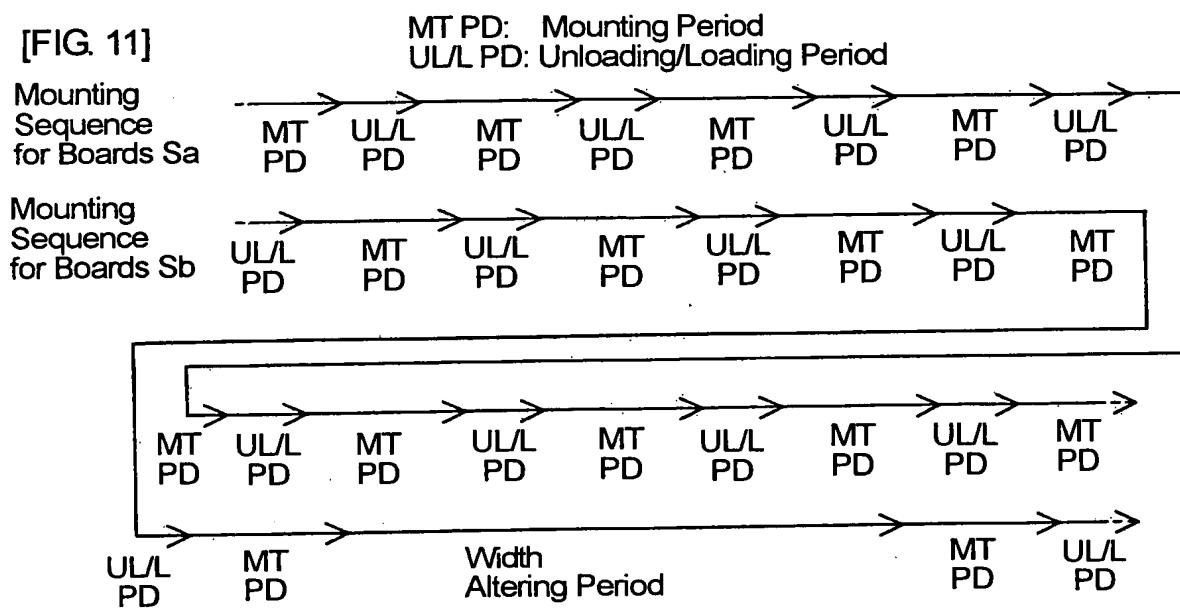
[FIG. 9]



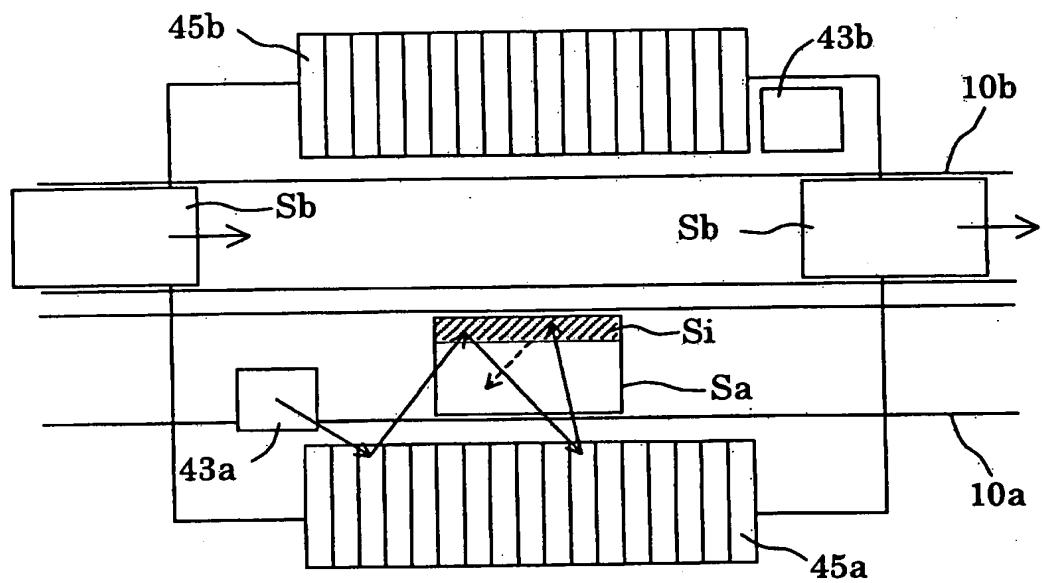
[FIG. 10]



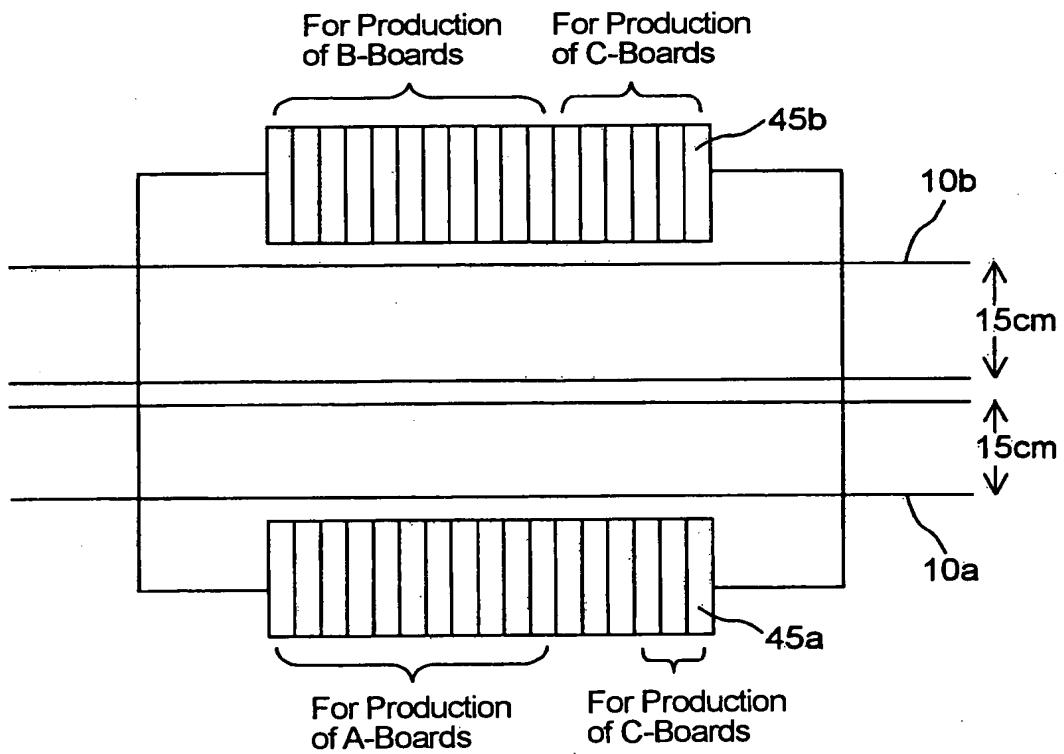
[FIG. 11]



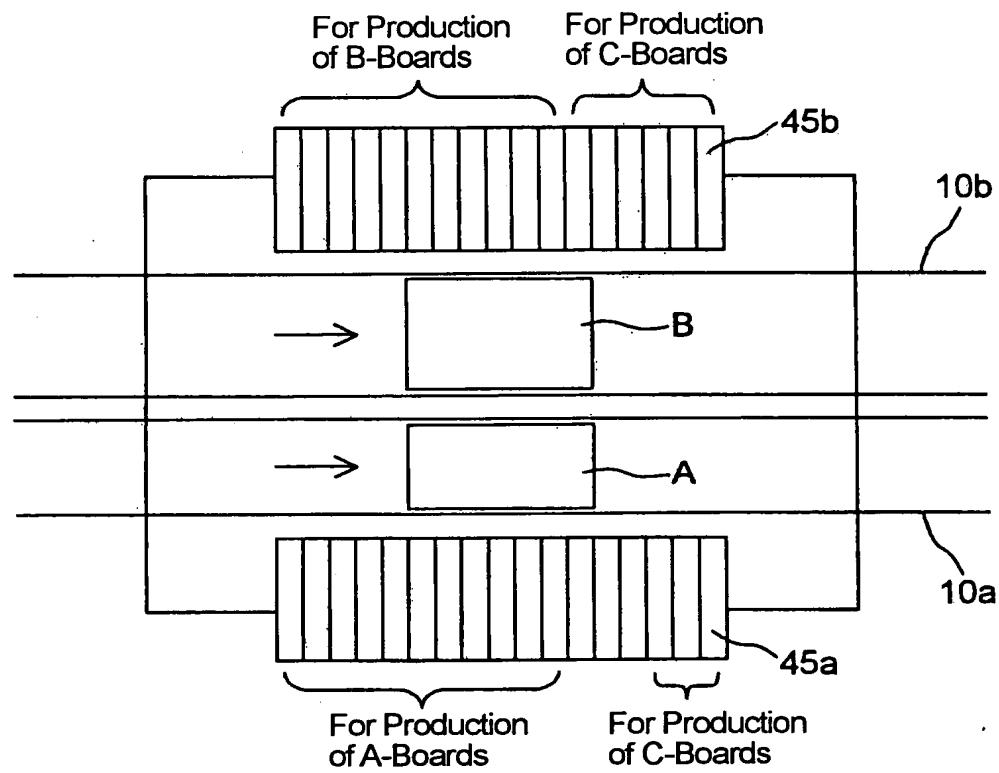
[FIG. 12]



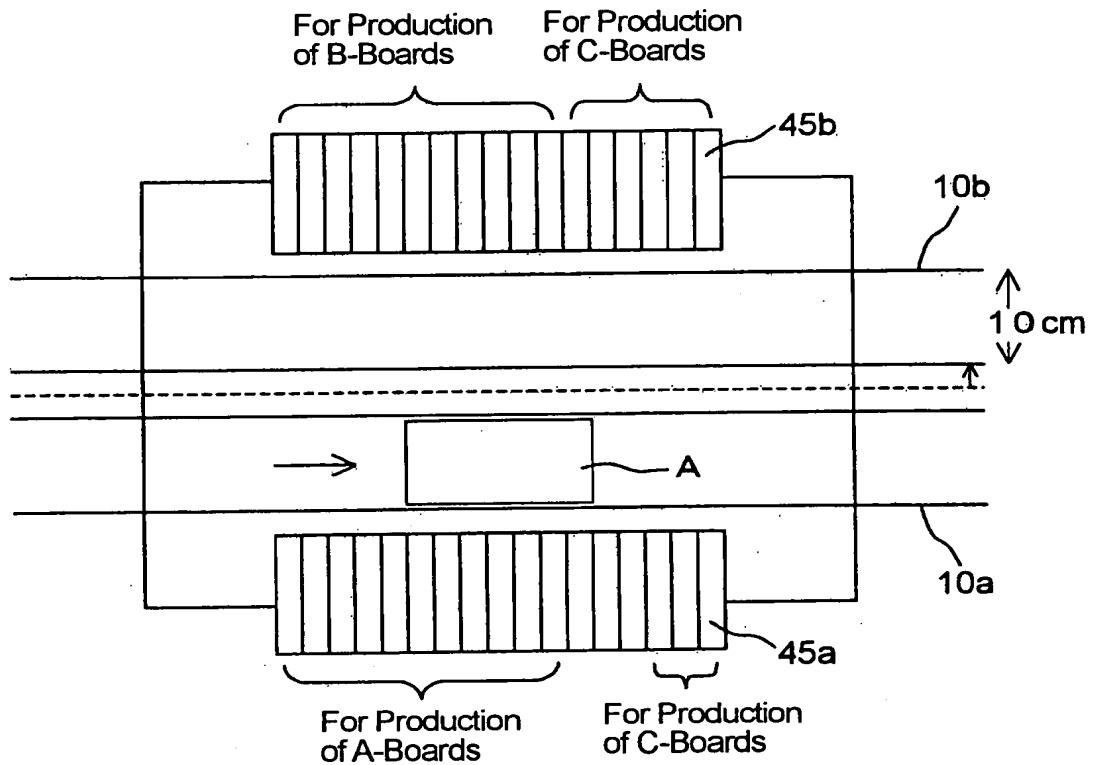
[FIG. 13]



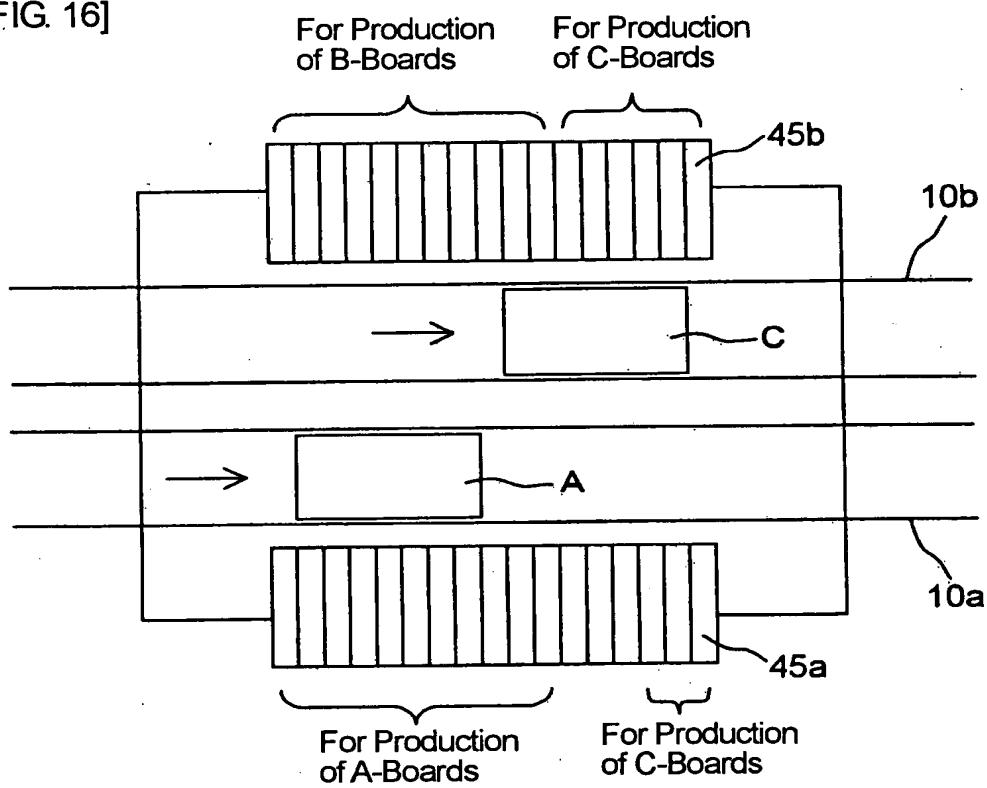
[FIG. 14]



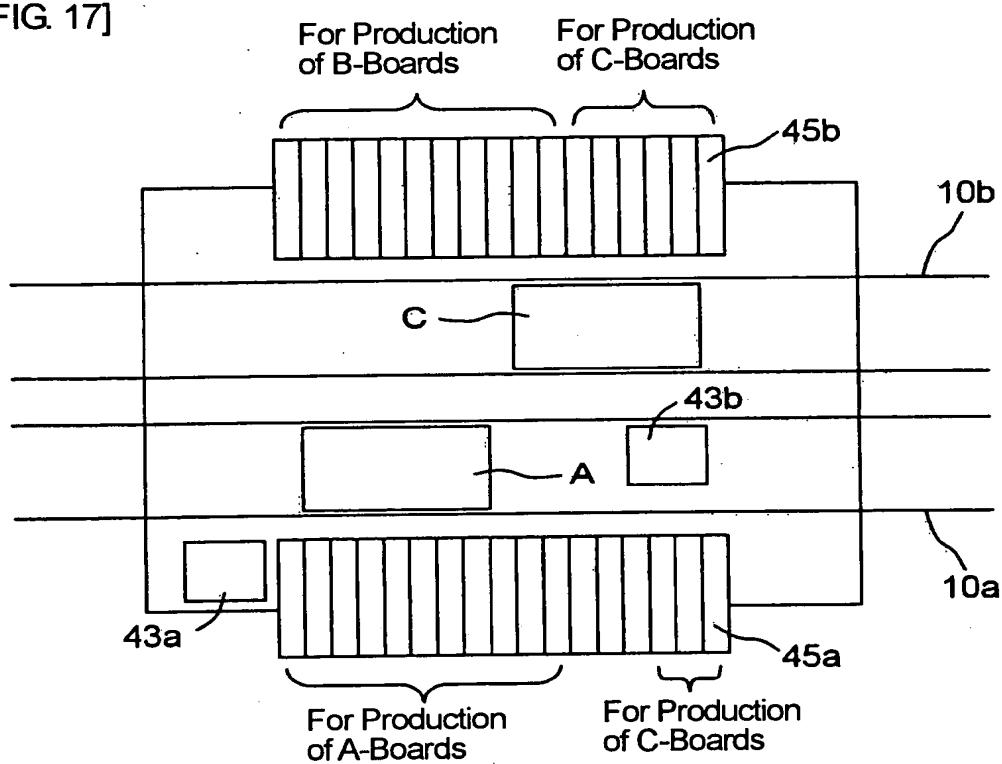
[FIG. 15]



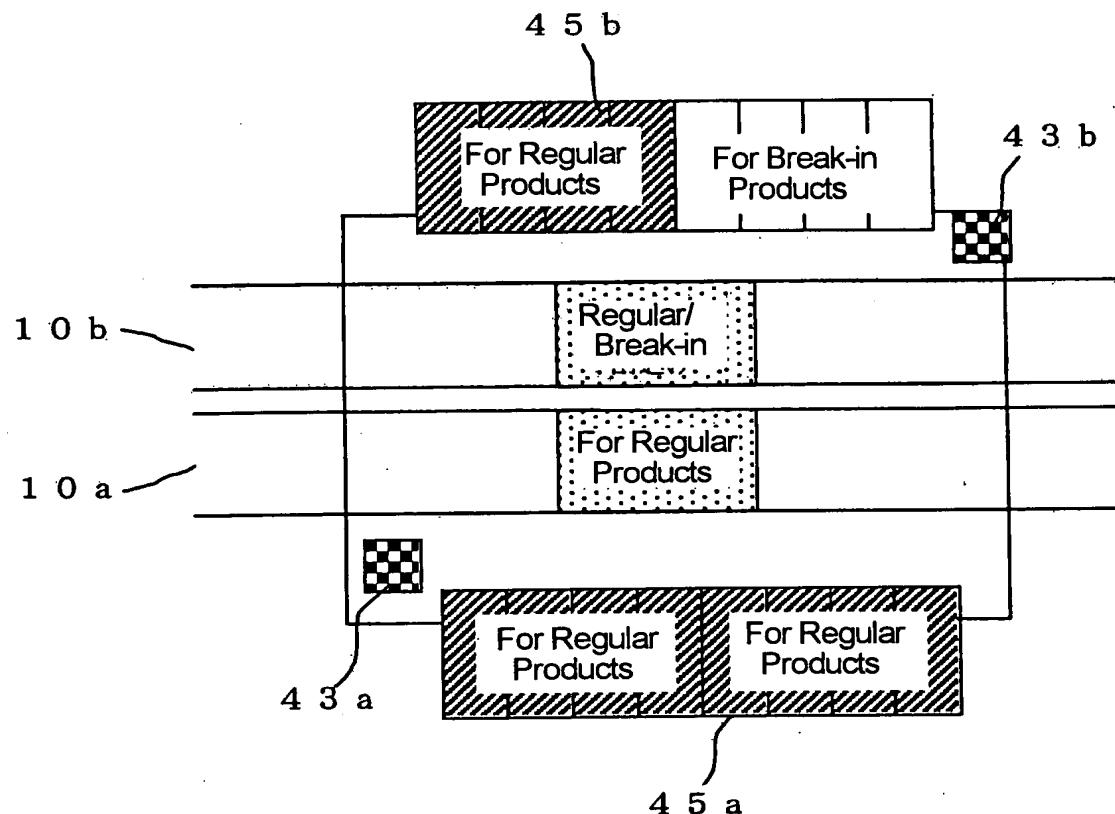
[FIG. 16]



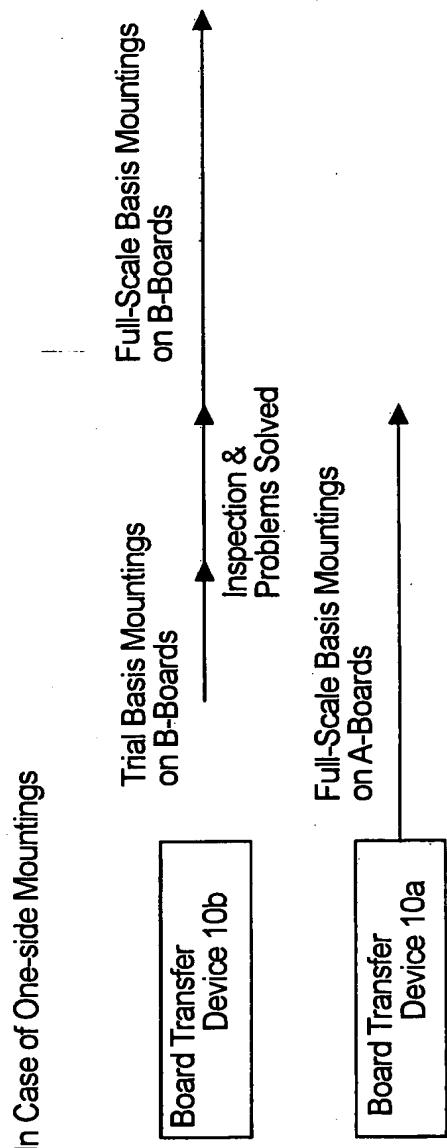
[FIG. 17]



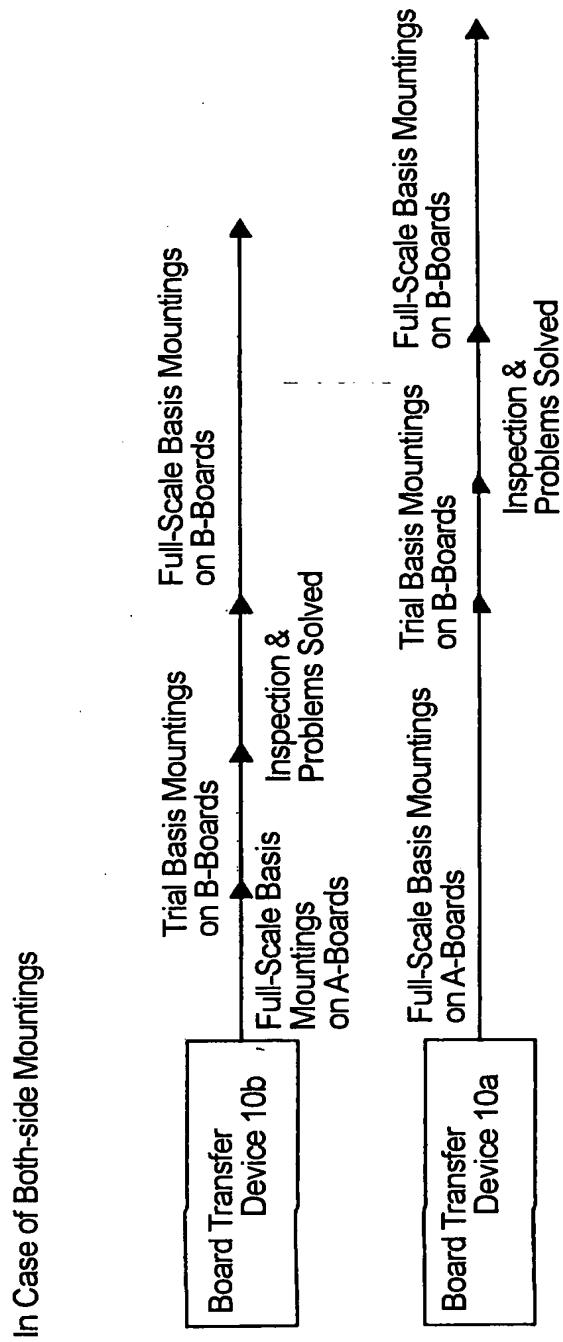
[FIG. 18]



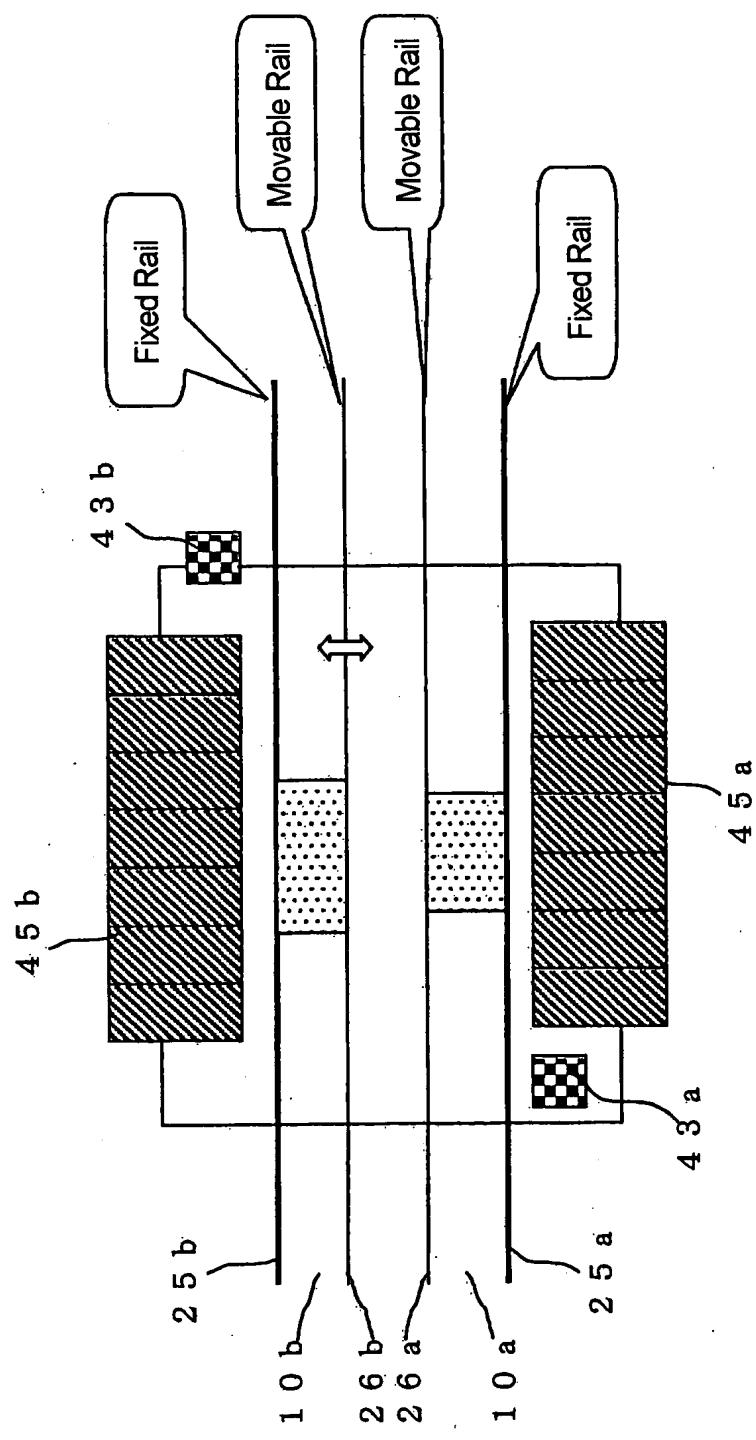
[FIG. 19]



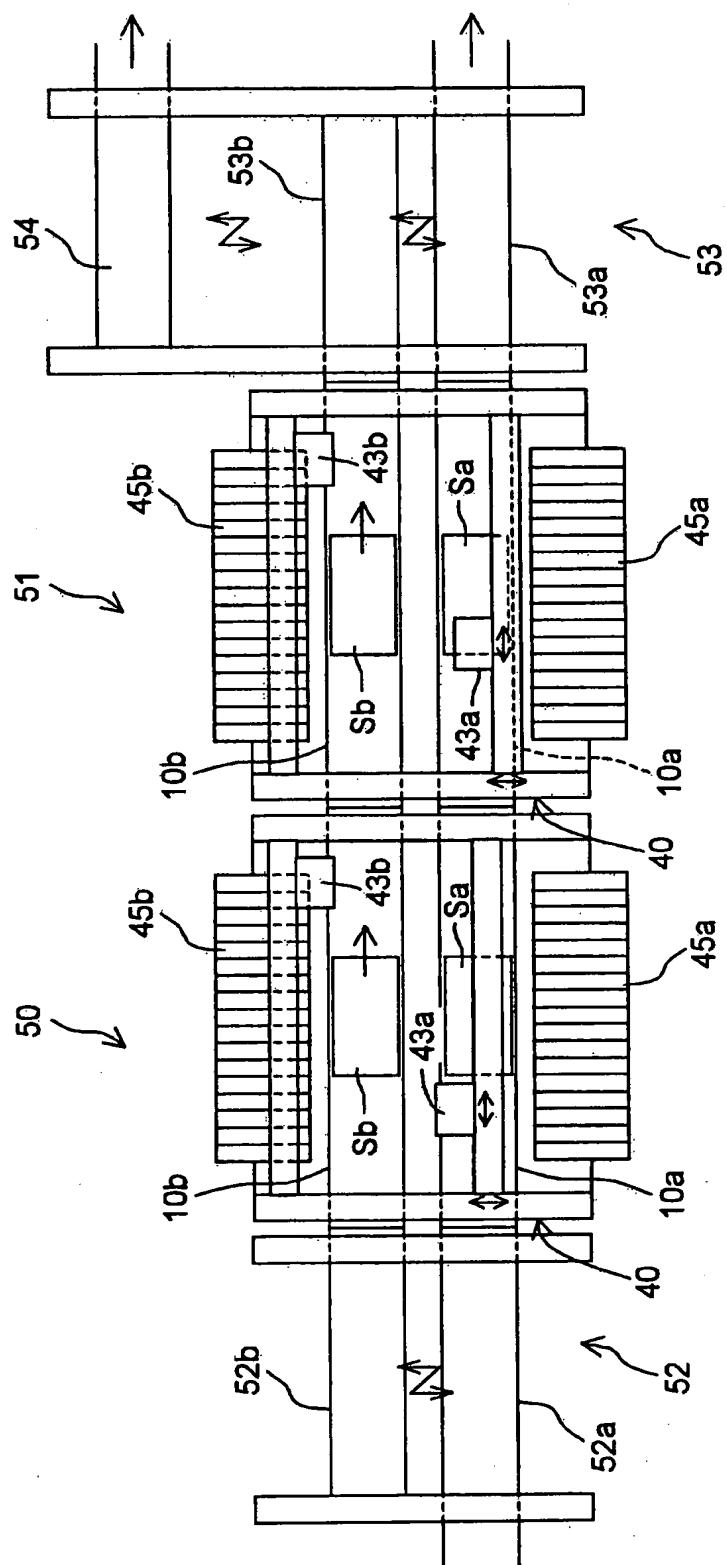
[FIG. 20]



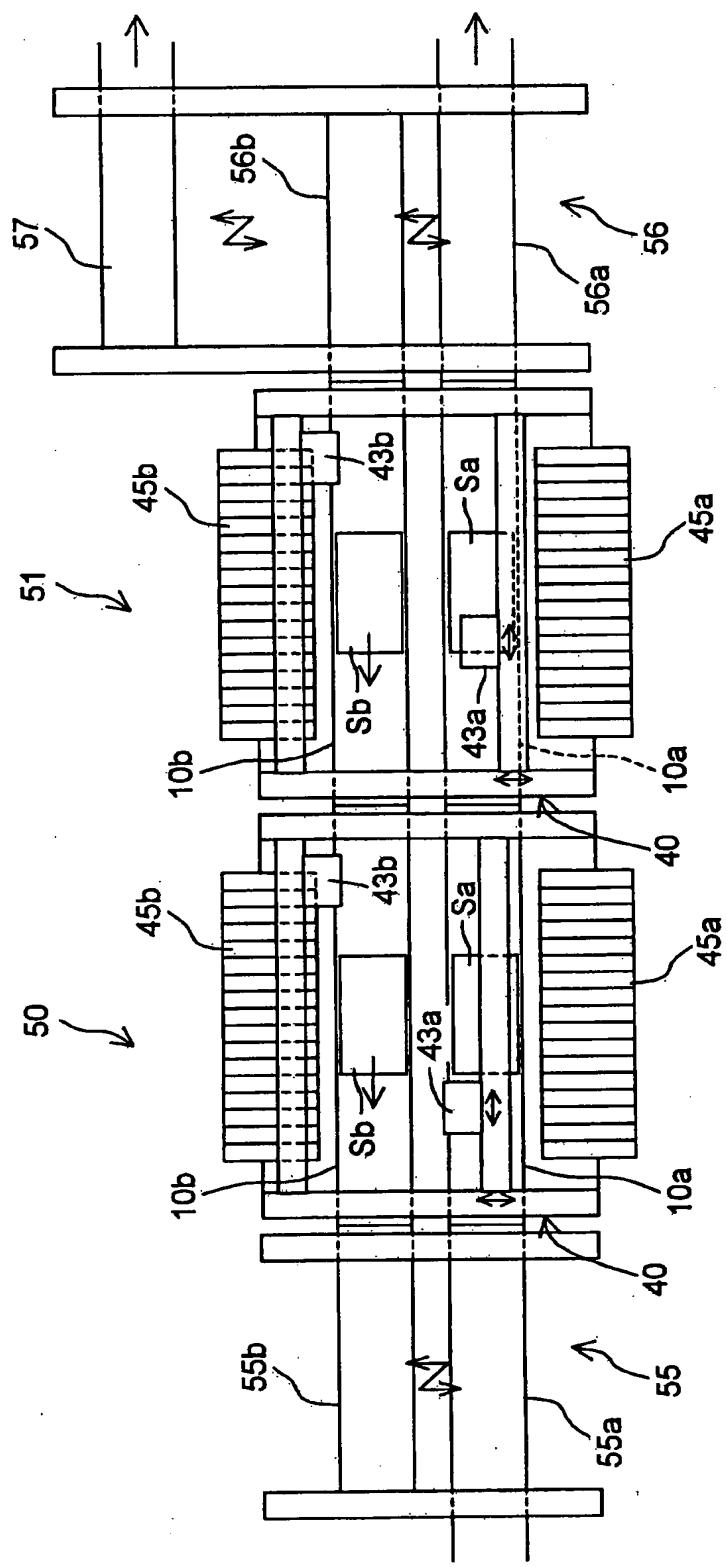
[FIG. 21]



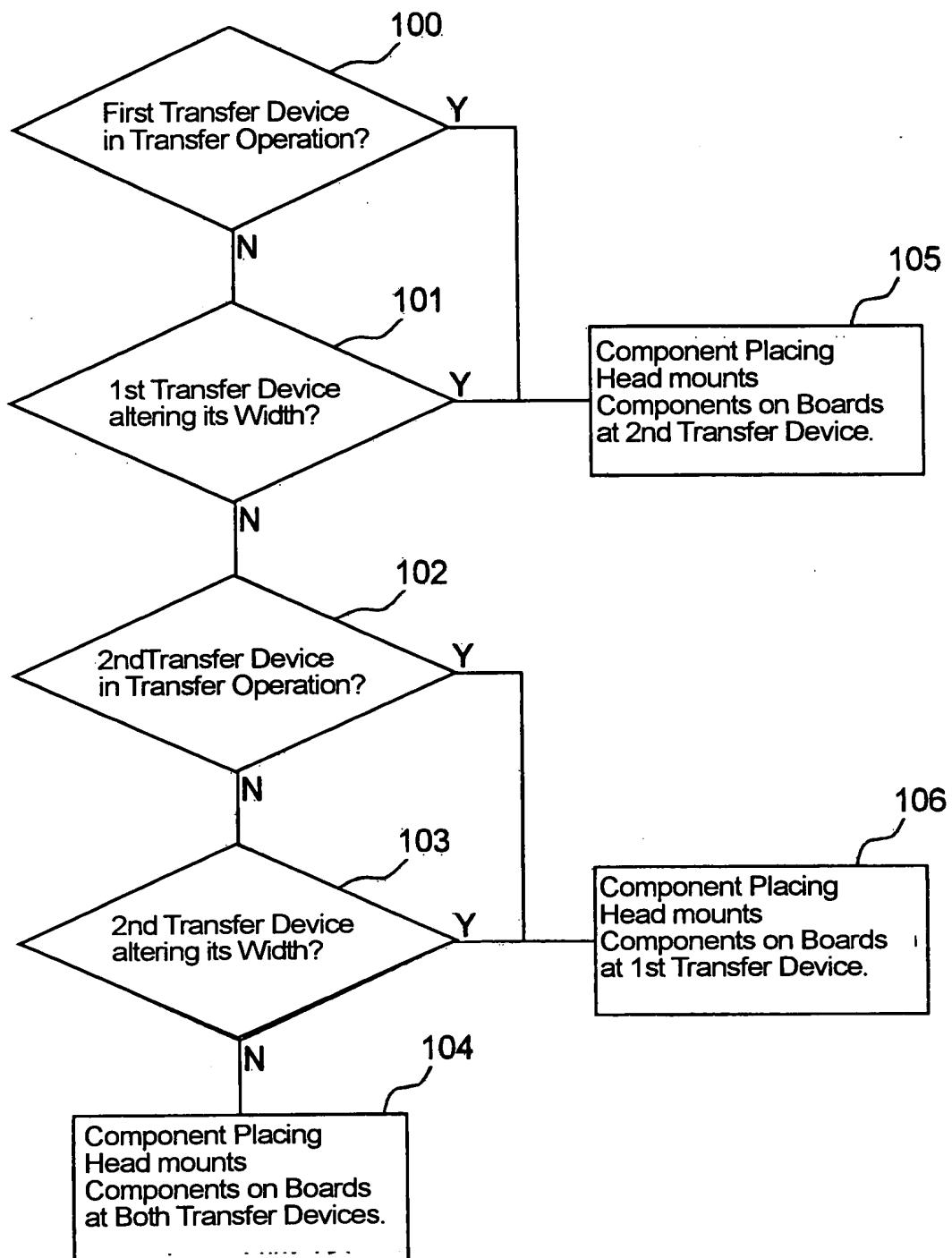
[FIG. 22]



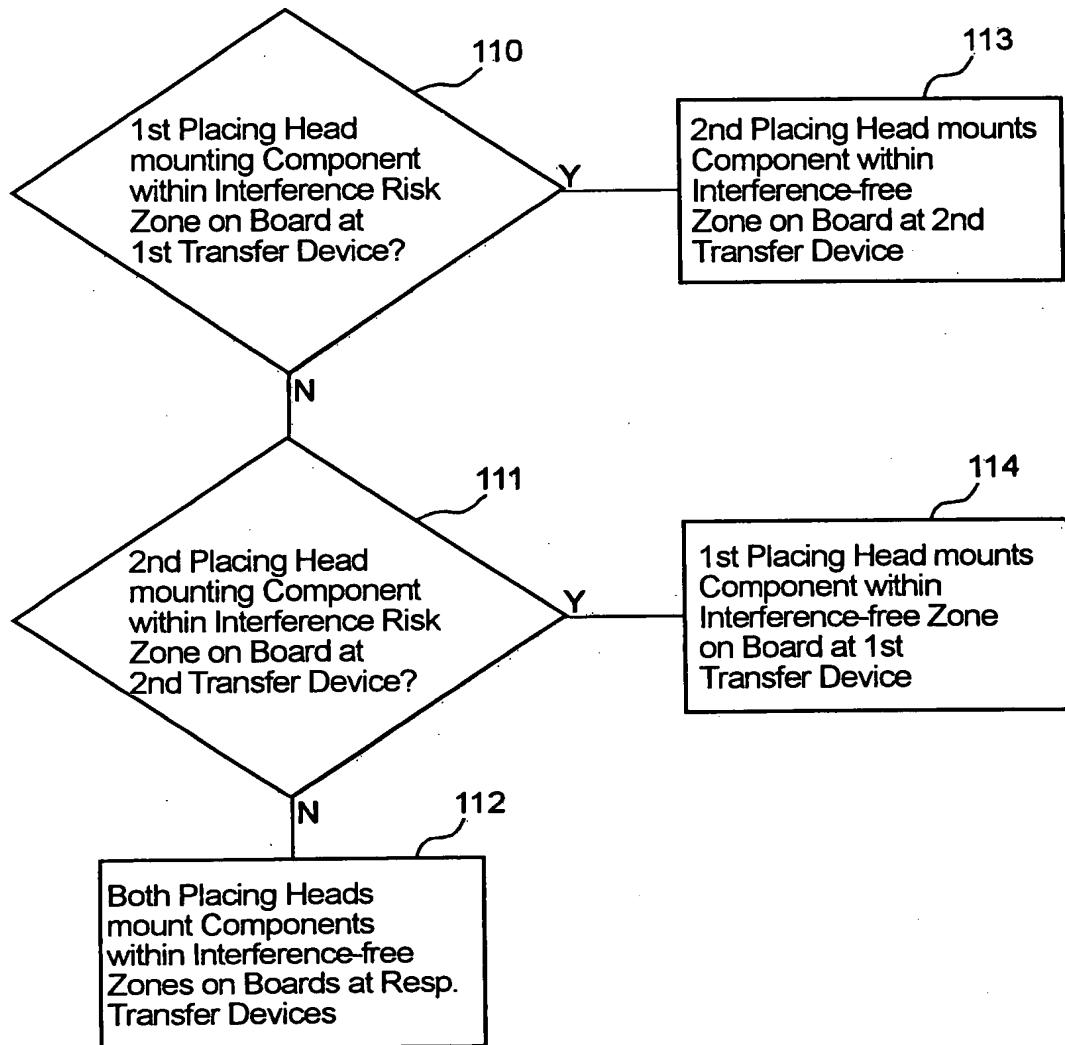
[FIG. 23]



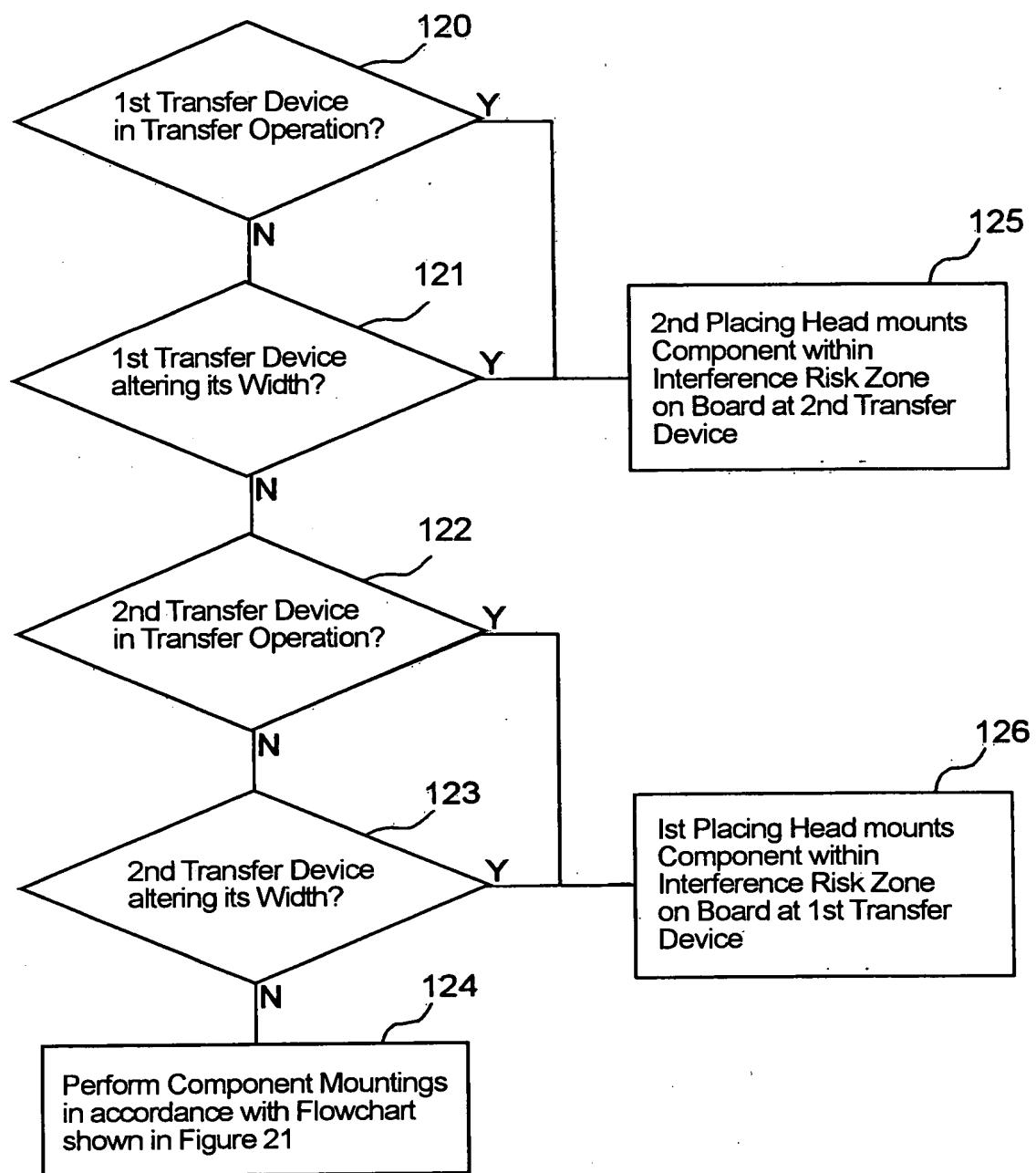
[FIG. 24]



[FIG. 25]



[FIG. 26]



[FIG. 27]

